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IMPERIAL IRRIGATION DISTRICT

OPERATING HEADQUARTERS • IMPERIAL, CALIFORNIA 92251

# Water Conservation Plan

# DRAFT

January 31, 1985

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Imperial Irrigation District
WATER CONSERVATION PLAN


Abstract

The District's Water Conservation Plan, dated January 1985, describes short-term programs to be implemented in 1985 through 1989; and long-term goals for water conservation, both structural and nonstructural, which are the direct responsibility of the District. It also describes many programs which are intended to aid water users in their application and use of water on-farm.

Altogether, after full implementation of the described projects and programs, it is estimated that up to 325,000 acre-feet of water can be salvaged each year.

Financing of projects will continue using funds available from the Water Conservation Fund plus monthly accruals into this fund at the rate of $1.75/AF of water sold. About $6.3 million will be expended during 1985 in designated programs. If additional funds become available, the programs described will be accelerated so that water savings can be achieved in the shortest practical time.

The plan is a "general plan" for improvement of conveyance, storage, and irrigation facilities in Imperial Valley. Conservation will result from the actions described in the Plan.

IMPERIAL IRRIGATION DISTRICT
WATER CONSERVATION PLAN

EXECUTIVE SUMMARY

## Introduction

This Water Conservation Plan is intended to be a general plan for improvement of the District's water distribution system. The following are emphasized: Physical improvements and management programs applicable to District facilities; and irrigation management programs by which the District can help agricultural water users to increase their on-farm irrigation efficiencies.

The District is recognized by the USBR as having one of the highest water use efficiencies (73-81 percent) in the lower Colorado River area. Nevertheless, the USBR has studied various "opportunities" the District has to conserve water. It is possible that the District can obtain outside funding for water conservation improvements in exchange for the quantity of water saved.

Indeed, it is important to realize that Imperial Valley's water system is an integral part of California's water system. Several other California entities, in particular the Metropolitan Water District, also divert water from the Colorado River, and hence the transfer and exchange of water are readily possible.

## Background

The Imperial Irrigation District is a public corporation organized in 1911 under the California Irrigation District Act, California Water Code Sections 2055 et seq. It is governed by a Board of Directors composed of five persons elected by the voters of the District.

## Water Rights

The water of the Colorado River is used by both the Upper Basin States (Colorado, New Mexico, Utah, and Wyoming) and the Lower Basin States (Arizona, California, and Nevada). In accordance with the Colorado River compact, both the Upper and Lower Basin States are each entitled to the exclusive beneficial consumptive use of 7.5 MAF of Colorado River water each year, in perpetuity. The California Limitation Act limits California's annual consumptive usage to 4.4 MAF, plus not more than one-half of any excess or surplus waters unapportioned by the Compact. The California Seven Party Agreement contains the following priorities:

| Priority | | | | |
|---|---|---|---|---|
| 1. | Palo Verde Irrigation District (For use exclusively upon 104,500 acres of land in and adjoining district) | | | |
| 2. | Yuma Project (For use on California Division, not exceeding 25,000 acres of land) | | | |
| 3a. | Imperial Irrigation District & Coachella Valley County Water District (Lands served by All-American Canal in Imperial and Coachella Valleys) | | 3.85 MAF | |
| 3b. | Palo Verde Irrigation District (For use exclusively on an additional 16,000 acres of land) | | | 4.40 MAF |
| 4. | Metropolitan Water District (For use on S. Cal. Coastal Plain) | 0.55 MAF | | |
| 5a. | Metropolitan Water District (For use on S. Cal. Coastal Plain) | 0.55 MAF | | |
| 5b. | City and County of San Diego | 0.112 MAF | | |
| 6a. | IID and CVWD | 0.3 MAF | | |
| 6b. | Palo Verde Irrigation District (For an additional 16,000 acres) | | | |
| | TOTAL ALLOCATIONS WITHIN CALIFORNIA | 5.362 MAF | | |

The District has a "present perfected right" to 2.6 MAF annually. One significance of the District's present perfected right is that in times of shortage, present perfected rights must be satisfied first. Of the users described in the Seven Party Agreement, only the Palo Verde Irrigation District, Imperial Irrigation District, and the Reservation Division, Yuma Project California (non-Indian portion) have present perfected rights. Although there is no explicit contractual prohibition against transfer of conserved or surplus water, which is a portion of water delivered to the District pursuant to federal contract, it would be appropriate to obtain the prior consent of the Secretary of Interior. Conserved or surplus water, which is a portion of District water appropriated pursuant to state law, may be used outside of the District boundaries if the District's Board of Directors finds it to be for the best interests of the District. See Water Code Sections 22259, 109, 1011, 1012, 1244, and 1706.

The gross area of the District is 1,062,290 acres, with about 465,000 acres in the central part of the District - known as "Imperial Unit" - being irrigated for agricultural purposes. Imperial Valley contains nine cities and towns, with a population of approximately 65,000; whereas about 27,000 people live in the Valley's unincorporated areas (1980 census data).

Revenues for the District's water operations are generated primarily from the $9/AF charge, which during a typical year in which 2.5 MAF of water are sold would result in $22.5 million of revenue. The water conservation fund is allocated $1.75 per AF of water sold, so that in a typical year the water conservation fund would be credited $4.375 million.

Imperial Valley contains relatively recent deposits of water-transported soil. The central irrigated area served by the District generally lies below sea level, and has fine-textured silts rather than sands usually associated with desert areas. The following soil series predominate in the developed area of the Valley.

| Soils Series | Acreage (approx.) | Description |
|---|---|---|
| Imperial | 300,000+ | Nearly level, moderately well-drained silty clay |
| Holtville | 80,000 | Nearly level, moderately & well-drained silty clay, silty clay loam & clay loam |
| Meloland | 40,000 | Nearly level, well-drained fine sand, loamy very fine sand, fine sandy loam, & silt loam |

Imperial Valley is seismically active, having had more than 60 earthquakes with recorded Richter Scale magnitudes 5.0 and greater since 1900.

Imperial Valley has a typical desert climate with summer daytime temperatures exceeding 100°F on more than 100 days each year, but the Valley has a mild and favorable climate the remainder of the year. The mean annual temperature (1914 to date) is 72.5°F, and the average annual rainfall has been 2.91 inches. Although hard frosts are uncommon, a low temperature of 16°F was once recorded; the high temperature of 119°F has been recorded several times.

Imperial Valley is subject to infrequent but sometimes intense storms. In 1976 Tropical Storm Kathleen caused extensive flood damage, which was exceeded in 1977 by the damage from Tropical Storm Doreen.

The Colorado River, the sole source of water for Imperial Valley, is one of the most physically developed and regulated rivers in America. "The Law of the River", as applied to the Colorado River, has evolved out of a combination of both federal and state statutes, interstate compacts, court decisions and decrees, contracts with the United States, an international treaty, operating criteria and administrative decisions. All of the foregoing have resulted in a division or apportionment of the waters of the Colorado River, among users thereof, or the rights to the "consumptive use" of the Colorado River waters. It must be pointed out that it is highly probable that in the near future, the Colorado will <u>not</u> yield a sufficient supply of water in dry and normal years to meet the increasing demands for its use.

The high salinity of Colorado River water presents acute problems for its users. Dissolved salts in the water damage the plumbing and appliances of domestic users. But for agricultural users, water salinity can destroy crop land, or at least reduce crop yields and restrict the choices of crops to be grown. The USBR estimated that economic losses in the Colorado River Basin average $53 million annually, but could triple by the year 2000 if no corrective measures are taken.

The ultimate repository for drainage water from the District is the Salton Sea, which is California's largest lake having a surface area of about 383 square miles, or 245,000 acres. The Sea receives drainage from about 1,075 square miles, or 690,000 acres, of irrigated lands in the Imperial, Coachella, and Mexicali Valleys.

During the past several years the elevation of the Salton Sea has become a sort of barometer, rising in the spring and falling in the summer and fall, usually ending each winter at an elevation higher than that of the previous year. Because agricultural drainage from Imperial Valley is the largest element of inflow to the Sea, those concerned about the rising level of the Sea suggest that the District should reduce its agricultural drainage in order to stabilize or lower the level of the Sea. Yet the engineering firm of Bookman-Edmonston concluded that inflow from the District has actually declined in recent years (1976-1983), whereas the other principal components of inflow to the Sea - rainfall, storm runoff, and inflow from Mexico during that same time period were substantially higher than normal.

Description of Water System

Imperial Dam is the diversion point on the Colorado River from which water is delivered to users in Arizona, Mexico, and California. Water is conveyed from this point to the Imperial Valley via the 80 mile long All-American Canal, which was built by the Bureau of Reclamation in the 1930's. Through this canal, over the past ten years, an average of 2.75 MAF of water annually has been conveyed to the head of the District system at Drop No. 1.

Several main canals branch off the All-American: the East Highline, Central Main, Westside Main, and New Briar Canals. Service to Imperial Valley is provided from these five main canals, or from the tributary lateral canals which they supply. In total there are 1,703 miles of irrigation canals within the IID. Four regulating reservoirs with an average storage capacity of 390 AF are included within the distribution system.

The Water Control Section of the District's Water Department is responsible for the transmission of water through the main canal system and its diversion to the laterals for distribution to the users. The distribution of water is a complicated task that involves the adjusting of the appropriate check, delivery and other structures. These structures are numbered in the thousands - there are approximately 3,400 check structures, and 5,600 delivery structures within the system. A coordinated procedure has evolved to handle this complex distribution process.

The primary user of water within Imperial Valley is the agricultural industry, which in 1983 used approximately 98 percent of the water supplied to the Valley. Average acreages of crops planted within the period 1974-1983 within the Valley are as follows:

| Crop | Acres |
|---|---|
| Alfalfa | 181,000 |
| Wheat | 129,000 |
| Cotton | 69,500 |
| Sugar Beets | 51,500 |
| Lettuce | 40,000 |
| Melons | 16,500 |
| Sudan | 16,000 |
| Misc. Garden | 16,000 |
| Misc. Field | 15,500 |
| Misc. Permanent | 14,000 |
| Sorghum, Grain | 11,500 |
| Carrots | 7,000 |
| Barley | 3,500 |
| Tomatoes | 3,500 |
| Citrus | 2,000 |

Methods used to irrigate these crops include sprinkler, furrow, border, corrugation, basin, drip, and tailwater return irrigation. Irrigation is the most important management practice of the Imperial Valley farmer, and must be adapted to the crop, soil conditions and other parameters as required.

The actual on-farm use of water can be derived by adding the consumptive use and leaching requirements and dividing by the on-farm application efficiency. Consumptive use refers to the amount of water utilized by crops to build up plant tissue, water transpired from plant surfaces and water evaporated from the soil surface. The typical average consumptive use within the Valley is estimated as 3.7 AF/acre. The leaching requirement is that amount of water applied in excess of the consumptive use to leach out salts from the soil profile, and is estimated to average 0.6 AF/acre for soils that have been sufficiently leached in the past ("reclaimed").

As part of its operating system, the District maintains an extensive drainage system. The lateral drain system is laid out to provide a drainage outlet for each 160-acre plot, and as such, the drains usually parallel the canals. The District is obligated to provide its drains at sufficient depth - generally six to ten feet deep - to accept tile drain discharge. Where the drain cannot be maintained at sufficient depth, a sump and pump is provided and maintained by the District. These drains are used to collect excess surface flows from agricultural fields ("tailwater"), subsurface tile discharges, and spills from canals and laterals. There are over 1,453 miles of surface drains that can be divided into three main areas: Alamo River System, New River System, and drains that flow directly into the Salton Sea. There are approximately 430 control structures installed along the drainage system.

Extensive maintenance is required for the entire irrigation and drainage system.

## Past District Water Conservation Programs

The District has initiated many water conservation programs, and additionally has participated in various programs in cooperation with governmental agencies. The District has also offered public education programs and have encouraged innovative on-farm practices.

Through the canal lining program, which has been in existence since 1954, over half of the District's water conveyance system - 871 miles of canals - has been concrete lined. Additionally, nine miles of canals have been replaced with concrete pipe. Concrete lining virtually eliminates seepage losses, and also reduces evaporation losses because of the smaller exposed water surface area. Pipelining can eliminate seepage and evaporation losses.

The District's four regulating reservoirs, providing a total storage capacity of 1,570 AF, have been built since 1975 at a total cost of $3.3 million. It is estimated that 6,200 AF of water are conserved annually through the use of these reservoirs, which help reduce operational spills from the canal systems they serve.

Another major structural improvement has been the installation of six miles of drainage lines parallel to the East Highline Canal to recover canal seepage losses. Water entering these drains is pumped back into the canal for delivery to farms. The total constructon cost was $492,000, and approximately $50,000 is spent annually for operation and maintenance costs.

Improvements in the operational procedures used to distribute and deliver water increase the efficiency of the water conveyance system. An on-going training program for zanjeros and hydrographers keeps these employees informed concerning the techniques of water measurement and management. Radio equipment installed in Water Department vehicles ensures the rapid communication required to provide operational flexibility, helping reduce operational spills. The flexibility of control is yet further enhanced through the remote electronic monitoring and control devices installed at 22 major structures, some of which are located on the All-American Canal and at the four reservoirs.

A program initiated in 1976 permits farmers to utilize drainage water, free of charge, for irrigation or reclamation. The effect of this program is to reduce inflow to the Salton Sea and encourage water use to its ultimate capacity. The California Fish and Game Department in cooperation with the District uses drain water to maintain a 1,400-acre wildlife habitat adjacent to the Salton Sea. The District has also created a 100-acre wildlife habitat in the New River bottom using reclaimed water.

The District has implemented a series of educational programs to encourage agricultural water conservation. These range in complexity from public meetings to full-scale demonstration programs, and include: demonstration of tailwater recovery systems; training irrigators to irrigate with minimum tailwater; training in various irrigation scheduling methods; field days teaching methods to measure water; and the demonstration program in irrigation scheduling using the neutron probe. In this program, soil moisture is monitored once or twice a week with a neutron probe and plotted on a graph. Based on the soil moisture data, recommendations are sent to the grower recommending when to irrigate and how much to apply.

The administrative tools used by the District Board of Directors to initiate many of the above-mentioned programs have been the "13-Point" and "21-Point" programs, which also began the tailwater assessment program. A daily inventory was begun. Users found to have excessive tailwater were assessed for that day a charge of three times the water rate for the water delivered. This "triple charge" program is still in effect.

The District has been involved in various cooperative studies and programs, researching innovative water conservation methods.

Different levels of involvement have been required of the District. For example, the District has helped the USDA Research Station in Brawley by: constructing a lysimeter to determine crop water consumption; helping construct an underground soil column laboratory, a reservoir, and a pumping station; installing four evaporation and weather stations; providing labor, equipment, and materials for a five-year irrigation efficiency study; and other ways.

The District has also cooperated with the University of California Extension Service farm advisory staff for many years, mainly by furnishing water flow data and water quality data. Recently the District has participated in the CIMIS and mobile laboratory programs sponsored by the University in conjunction with DWR.

Imperial Valley farmers have been practicing water conservation from the beginning of development in the Valley. The land must be properly tiled, graded, smoothed and otherwise prepared for the uniform application of water to the crop. Over 80 percent of Imperial Valley fields have been tiled for proper drainage, a necessity for removal of excess salts from the soil root zone. Other management practices include land leveling and conscientious use of both traditional and innovative methods to ensure the uniform application of water to the soil.

The water conservation efforts of the District and the local farmers have saved water and reduced agricultural drainage into the Salton Sea. The measurement of the latter quantity is a prime indicator of the overall effectiveness of water conservation. Because of variations from year to year in cropping patterns, weather, economic conditions, and other factors, it is necessary to compare Salton Sea inflow for a series of years to obtain a true picture. It is clear from available records that the average District inflow has been on the decline for the past ten years.

## Other Programs for Future Consideration

The purpose of this section is to describe briefly some possible water conservation programs for future plans. None of these programs are incorporated within the 1984 Plan, either because of prohibitive cost, or the selection of more attractive options. No discussion of feasibility is made herein.

Structural programs could include: changing measurement structures to improve their accuracy; pipelining of canals to eliminate seepage and evaporation; desalinizing a portion of the Colorado River water upstream of delivery to District system to lower the leaching requirement.

Operational programs could include: standardizing delivery head increments to allow "matching" of orders to reduce spill; sequential water deliveries to allow timely movement of these deliveries.

Administrative programs could include: water allotments based on specific crop requirements; accelerating water rate structures; monetary and other incentives for those who generate small amounts of tailwater; the development of a conservation plan for nonagricultural users of water within the District.

On-farm programs could include the selection and possible development of crops with lower water usage; and programs to reduce excessive leaching on sandy soils.

The USBR in its Draft Special Report (September 1983) concludes that "cost-effective water conservation opportunities are available to the District." They emphasize the need for further detailed study, eventually leading to funding of selected programs. The Bureau envisions that construction would begin in 1990, occur over a five to twenty year period, with a total capital cost of $130.9 million expended to conserve a portion of 350,000 AF potentially available.

In a report dated December 1981, the DWR suggested various programs to save an estimated 178,000 AF of leaching water and tailwater, and 50,000 AF of canal spills.

Other suggestions for conserving water have come from: individual farmers; and the Citizen's Salton Sea Committee.

Water Conservation Plan

The District's 1985 Budget was approved by its Board of Directors in December 1984, and within this budget is an allocation of $6.4 million for the water conservation program. Assuming that in 1985 a total of 2.5 MAF of water at $9/AF are sold, the water conservation budget would represent 28 percent of the Water Department's budget.

An accounting procedure will be adopted to provide for separate accounting of water delivered vs. water billed. This change of procedure will allow for the use of billing records to determine the actual quantities of water delivered to users.

One of the early tasks in 1985 will be to develop a new tailwater assessment program and to evaluate the quantity of tailwater within the District.

A statistical sampling plan for the measurement of operational spills will be formulated, preparatory to implementation.

To quantify the amount of lateral canal seepage, the following program will be implemented in 1985. First, a map showing all unlined sections of laterals will be prepared along with an inventory thereof. These will be rated as to expected seepage characteristics in general terms of high, low and lowest.

Superimposed on the map will be a soils map which should aid in the determination of seepage rates. Several seepage measurements will be made per year using ponding studies. Using the aforementioned map and the results of the ponding tests, an annual estimate will be prepared of the total seepage in unlined laterals. An annual memorandum report will be prepared in which relevant data, test results and an annual estimate of seepage will be reported.

A tile flow monitoring program will be implemented to augment the District's current sump study by installing recorders on ten tile outlets in the areas of the District not covered by sumps. This data will be used to establish flows from tile for the whole District as part of the total water budget. An additional study will be performed to evaluate the actual leaching fraction necessary to grow crops in Imperial Valley. The leaching requirement will vary for different crops, soil types, and other parameters.

## Financing Water Conservation

Past funding of projects related to water conservation has been accomplished using a portion of the revenues from water sales as described earlier.

It is anticipated that future water conservation projects and programs be funded in the same manner. However, during recent months proposals that water conservation projects be paid for by "others" have been made. This idea is believed to stem from the Bureau's study and draft report of water conservation opportunities in which it is estimated that there are water losses within Imperial Irrigation District which might be salvaged. Furthermore, assuming that the District now delivers the full agricultural water requirement to farmers, it appears that such salvaged water could be available for use by other California entities, who might be willing to finance conservation projects in exchange for use of the salvaged water.

By Resolution 8-84, adopted January 24, 1984, the District invited "other members of the Seven Party Agreement, the Bureau of Reclamation and beneficial users, including geothermal industry, within the District...to discuss water conservation opportunities...including the cost and method of payment for such conservation, and the potential use by the District and other members of the Seven Party Agreement of the water thus conserved".

It is unknown at this time if or when agreements might be made which would provide moneys to the District from any of these other parties.

Discussions have taken place, but no firm agreement appears imminent. The two main components of any agreement - water quantities to be salvaged, and cost of specific water conservation works to salvage the water - have not been determined. Studies to delineate these components will be necessary.

The Bureau's new study "Imperial Irrigation District Canal Lining and System Improvement" (CLSI) USBR Draft Plan of Study, July 1984, has the purpose to "further study the application of water conservation measures to existing Imperial Irrigation District irrigation facilities, operations, and practices in promoting more efficient use of water, and to develop an additional water supply for future needs in the District and in Southern California".

Other means of financing, such as loans or bond sales, may be considered at some future time, as will increased rates or assessments if deemed necessary.

In the Bureau's Draft Special Report dated September 1983, it is estimated that the capital cost of "cost effective" programs would be $131 million. The District has not evaluated this estimate, but is now participating with the Bureau in the new study on an equal cost-sharing basis. It is anticipated that estimates of cost and quantities of water savings will be refined at the conclusion of this study. District staff will continue independent studies as well and may recommend retaining consultants for this purpose.

Expenditures on water conservation projects and programs, structural improvements as well as management programs, shall be made at the maximum level commensurate with funding capabilities.

## Structural Programs

The District has budgeted $2.25 million for the 1985 canal lining program. The canal lining schedule is based on seepage potential, hydrilla infestations, and operational considerations.

Construction of a $1.2 million regulatory reservoir at the Trifolium Extension heading of the Westside Main Canal is scheduled for 1985. The total capacity will be roughly 300 AF, and it is estimated that 4,100 AF of operational spill per year will be conserved by this strategic placement of a reservoir adjacent to the Trifolium Extension spill structure.

It is projected that ten timber slide gates on spill structures will be replaced with aluminum gates to eliminate leakage.

## Operational Programs

A study will be made to determine: the type and functions of a computerized SCADA system; and any necessary changes to upgrade the communication network. Specifications will be prepared for procurement of equipment in 1986.

The zanjero training program will continue as part of the normal on-going training.

## Administrative Programs

Additional zanjeros will be employed to improve flexibility of delivery and to monitor tailwater. Additional water conservation employees will be hired.

The tailwater assessment program will be continued but scrutinized for ways in which it can be improved.

## Educational Programs

Six demonstration tailwater recovery systems will be constructed to determine the effectiveness and costs of tailwater recovery systems.

Newspaper articles, brochures and instruction booklets relating to water conservation will be released through the Public Information and Community Services Section.

Four field irrigation demonstrations will be conducted. Training will be provided for ten growers and their irrigators to irrigate using methods that produce minimum tailwater. A series of video irrigation training programs will be developed.

## Cooperative Programs

The District has budgeted $162,000 for a 50 percent cost-sharing program with the USBR on canal and system improvement study. Priority is given to studying seepage losses of the East Highline Canal and the possibility of constructing an 8,000 AF reservoir along the All-American Canal.

A joint study with a research team from the USDA will be made of fluctuations that occur in lateral canals, and in determining ways of minimizing these fluctuations.

An allocation of money to pay for cost of electricity to pump drain water for irrigation has been made. This will help an on-going study being performed by the USDA.

A pond will be constructed at the outlet of the Elder 14 Drain into the New River to divert about 825 AF of drainage water each year to this waterfowl habitat area.

The irrigation scheduling program conducted in cooperation with the USBR will be continued, hopefully involving 12,000 to 15,000 acres.

Research Programs

Preliminary design of a spill interceptor canal and reservoir, to intercept flows from the East Highline System into the Alamo River, will begin.

A complete analysis of data gathered from the "modified demand irrigation trial" program will be made.

A computerized water management program developed by the USBR will be implemented on one or two zanjero runs.

Miscellaneous Programs to Reduce Salton Sea Inflow

The Water Conservation Plan is designed to reduce losses, most of which contribute to the inflow to the Salton Sea. Accordingly, other elements of inflow remaining unchanged, the level of the Sea is expected to decline. However, recognizing that conservation programs take time to implement, whether that time be five years or twenty years, other programs need to be considered which perhaps can be applied in a shorter time. Some of the possible alternatives are discussed herein.

Several proposals will be studied during 1985 which are not specifically in the Water Conservation Plan including the following:

(1) Spreading drain water on available idle land, by ponding, flooding, or sprinkling;

(2) Storm detention basins on the East and West Mesas, requesting assistance from the U.S. Corps of Engineers;

(3) Irrigation with free drain water through cooperation with volunteer landowners, alternating with canal water;

(4) Pumping water from Salton Sea to shallow ponds adjacent to the Sea;

(5) Pumping water from drains to shallow ponds on East and West Mesas, or other available lands, for wildlife ponds or marshes or other uses;

(6) Support continued investigation of diverting New River at or south of Mexican border to Laguna Salada in Mexico;

(7) Separating tile drain flows from tailwater to allow reuse of surface runoff.

## Environmental Issues

In accordance with the California Environmental Quality Act, the District has by resolution adopted the State CEQA Guidelines for application to the District.

These guidelines provide that certain programs are exempted from preparation of environmental assessments. Programs in this category include concrete lining existing District canals, pipelining portions of laterals and drains, installing road crossings, and replacing existing structures.

The District has prepared a declaration of negative impact for each of its regulating reservoirs and will continue to file this type of environmental review for similar projects.

As major projects in the Water Conservation Plan are prepared for implementation, an environmental assessment as required by the State guidelines will be prepared.

The major environmental issues expected to be of concern are:

(1) Reduction of flows in drains;

(2) Reduction of inflow to Salton Sea;

(3) Increase in salinity of drain waters;

(4) The impact of these factors on fish and wildlife, recreation, and aesthetic values.

## Conclusions

This Plan delineates specific projects and programs which either are proven to save water, or have a high degree of potential for conservation by increasing efficiencies of District's systems and farmer's investigation operations.

As stated in the Introduction, this Plan is a general plan for improvements, both structural and nonstructural, of conveyance, storage, and irrigation facilities in Imperial Valley. Conservation of water will result from the actions described in the Plan.

The Plan should be reviewed annually by the Board of Directors, and modified as conditions change.

The time schedules and proposed future expenditures are obviously subject to review, for no one can predict the future.

As funds may become available from outside sources, schedules will be tightened and expenditures accelerated in order to accomplish the earliest construction of structural works.

At this point and presumably throughout the period of implementation, the Plan is a voluntary plan on the part of District water users. There will have to be continued monitoring of tailwater - with special assessments and penalties - but by coordinated efforts, landowners and water users will continue to improve their use of water to ensure that it is used wisely.

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# CHAPTER I

## INTRODUCTION

### A. Purpose

The Water Conservation Plan of Imperial Irrigation District is intended to be a general plan for improvement of the District's water distribution system during the next 10 to 15 years -- including extension of current programs. The planned improvements are expected to increase efficiency, reduce maintenance costs, and subsequently result in water savings. Emphasis will be on physical improvements and management programs applicable to District facilities, and irrigation management programs in which the District can provide leadership, information and advisory services to help the water users increase efficiencies in their application of irrigation water on Imperial Valley lands.

Imperial Irrigation District is responsible for delivering Colorado River water to about one-half million acres of land within Imperial Valley for agricultural, domestic, industrial, and other beneficial uses. This supply is the sole source of water for the Valley. Rainfall and runoff are infrequent and insufficient; groundwater is not usable.

Before the District was organized in 1911, private developers, beginning in 1901, had constructed extensive systems of earth canals and laterals to serve about 220,000 acres of land in Imperial Valley. The District subsequently consolidated and assumed control of operations of all private facilities into one system, later extending and completing conveyance facilities enabling it to deliver water to the present service area of 500,000 acres. An extensive drainage system was constructed to beginning in 1923, and on-farm tile drainage systems were installed by landowners beginning in 1929.

During these years of construction, the District operated and maintained the canal and open-drain system, as necessary, to provide service to water users. Removal of silt and burning of weeds were constant maintenance problems. During the past 50 years, the District has gradually improved the systems by replacing timber and rubble structures with concrete, timber bridges and corrugated iron culverts with reinforced concrete pipe, by concrete-lining over one half of the lateral canal system and installing remote and automatic controls on major structures.

During the past eight years, four regulating reservoirs have been constructed to conserve water as well as provide more flexible service. The District has implemented a comprehensive water conservation program which will be described in detail herein. These programs have gradually improved the efficiency of the District's system and resulted in saving water that was previously lost to seepage or operational spills.

## B. SCOPE

The scope of this plan is indeed broad - to describe water conservation within the Imperial Irrigation District. The District is a unique, complex and expansive system of water distribution and usage, and to describe it in general terms would at best be less than meaningful and at worst convey an erroneous impression. Therefore, it was decided to write this Plan as a document that will serve as a single-source reference concerning water conservation within the District.

To accomplish the task of compiling this Plan in a logical and orderly framework, the Plan is divided into five chapters. Chapters I, II, III and IV are intended to provide a backdrop upon which Chapter V, the Plan itself, is superimposed. Chapters II, III, and IV may be thought of as successive overlays of information leading up to the presentation of the Water Conservation Plan in the last chapter.

Chapter II, Background, begins with a description of the unique geography of the Imperial Valley. It continues with a description of the history of the developments within the Imperial Valley, in particular, the Imperial Irrigation District.

Chapter III is an extensive description of the distribution and usage of water within the District. The District's irrigation and drainage conveyance systems are portrayed in considerable detail, as are the agricultural uses of water within the system. The urban, industrial, recreation and wildlife uses of water are briefly discussed.

The purpose of Chapters IV, and V is to serve as an idea bank for water conservation programs. Included are past District programs and accomplishments, as well as programs that have been suggested by agencies and groups outside the District.

Chapter VI is the culmination of this entire report and is the Water Conservation Plan. The essence of this chapter is the discussion of the programs that the District plans to implement. The 1985 Plan is very specific, and is tied in closely with the short-term plans outlined for the nominal period through 1989. Discussion of the District's present vision of long-term goals is given.

Environmental issues and financing are discussed, for those are constraints to any large-scale improvements of the District's water system.

## C. DISTRICT ORGANIZATION AND AUTHORITY

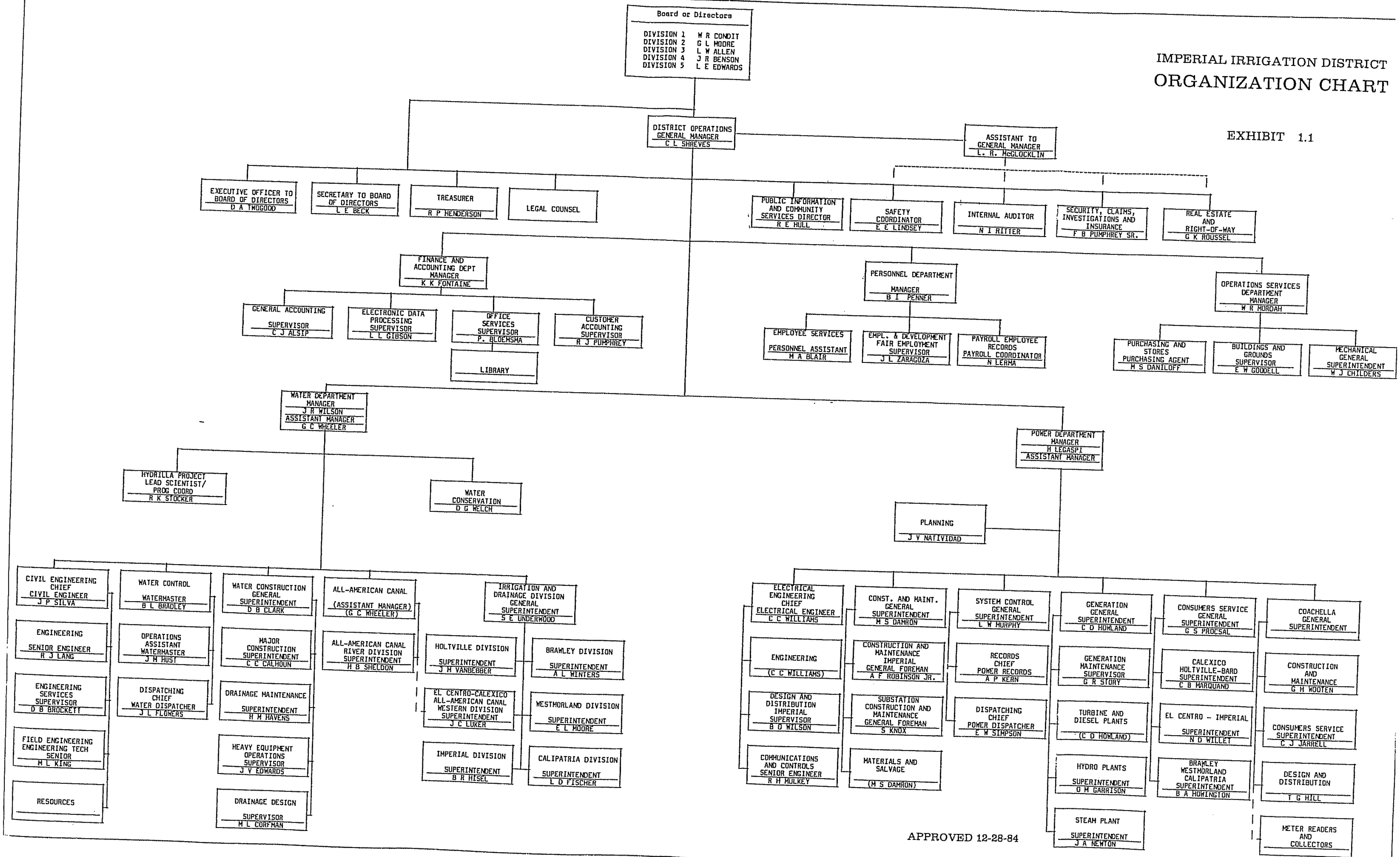
The District is a public corporation organized in 1911 under the California Irrigation District Act, California Water Code Sections 2055 et seq (the "Law"). It is governed by a Board of Directors composed of five persons elected by the voters of the District.

The District has segregated its operations into two main departments, the Water Department and the Power Department. The diversion and delivery of Colorado River water for irrigation and domestic uses, and the operation and maintenance of drainage canals and facilities are performed by the Water Department. The production, transmission and distribution of power are functions of the Power Department. Separate accounting records are maintained for each of the two departments.

Exhibit I.1 is the District Organization chart showing management personnel for the Departments, Sections and Units.

# IMPERIAL IRRIGATION DISTRICT
# ORGANIZATION CHART

EXHIBIT 1.1




APPROVED 12-28-84

# SALTON SEA AREA CAPACITY CURVES

00

| ELEVATION (feet) | SURFACE AREA (acres) | CAPACITY (acre-ft) | GROSS EVAPORATION (acre-ft/yr) E=5.86 ft/yr |
|---|---|---|---|
| -229.75 | 235625 | 6559250 | 1380750 |
| -229.70 | 235750 | 6571100 | 1381500 |
| -229.65 | 235875 | 6582950 | 1382250 |
| -229.60 | 236000 | 6594800 | 1383000 |
| -229.55 | 236125 | 6606650 | 1383750 |
| -229.50 | 236250 | 6618500 | 1384500 |
| -229.45 | 236375 | 6630350 | 1385250 |
| -229.40 | 236500 | 6642200 | 1386000 |
| -229.35 | 236625 | 6654050 | 1386750 |
| -229.30 | 236750 | 6665900 | 1387500 |
| -229.25 | 236875 | 6677750 | 1388250 |
| -229.20 | 237000 | 6689600 | 1389000 |
| -229.15 | 237125 | 6701450 | 1389750 |
| -229.10 | 237250 | 6713300 | 1390500 |
| -229.05 | 237375 | 6725150 | 1391250 |
| -229.00 | 237500 | 6737000 | 1392000 |
| -228.95 | 237650 | 6748950 | 1392875 |
| -228.90 | 237800 | 6760900 | 1393750 |
| -228.85 | 237950 | 6772850 | 1394625 |
| -228.80 | 238100 | 6784800 | 1395500 |
| -228.75 | 238250 | 6796750 | 1396375 |
| -228.70 | 238400 | 6808700 | 1397250 |
| -228.65 | 238550 | 6820650 | 1398125 |
| -228.60 | 238700 | 6832600 | 1399000 |
| -228.55 | 238850 | 6844550 | 1399875 |
| -228.50 | 239000 | 6856500 | 1400750 |
| -228.45 | 239150 | 6868450 | 1401625 |
| -228.40 | 239300 | 6880400 | 1402500 |
| -228.35 | 239450 | 6892350 | 1403375 |
| -228.30 | 239600 | 6904300 | 1404250 |
| -228.25 | 239750 | 6916250 | 1405125 |
| -228.20 | 239900 | 6928200 | 1406000 |
| -228.15 | 240050 | 6940150 | 1406875 |
| -228.10 | 240200 | 6952100 | 1407750 |
| -228.05 | 240350 | 6964050 | 1408625 |

| ELEVATION (feet) | SURFACE AREA (acres) | CAPACITY (acre-ft) | GROSS EVAPORATION (acre-ft/yr) E=5.86 ft/yr |
|---|---|---|---|
| -228.00 | 240500 | 6976000 | 1409500 |
| -227.95 | 240625 | 6988100 | 1410225 |
| -227.90 | 240750 | 7000200 | 1410950 |
| -227.85 | 240875 | 7012300 | 1411675 |
| -227.80 | 241000 | 7024400 | 1412400 |
| -227.75 | 241125 | 7036500 | 1413125 |
| -227.70 | 241250 | 7048600 | 1413850 |
| -227.65 | 241375 | 7060700 | 1414575 |
| -227.60 | 241500 | 7072800 | 1415300 |
| -227.55 | 241625 | 7084900 | 1416025 |
| -227.50 | 241750 | 7097000 | 1416750 |
| -227.45 | 241875 | 7109100 | 1417475 |
| -227.40 | 242000 | 7121200 | 1418200 |
| -227.35 | 242125 | 7133300 | 1418925 |
| -227.30 | 242250 | 7145400 | 1419650 |
| -227.25 | 242375 | 7157500 | 1420375 |
| -227.20 | 242500 | 7169600 | 1421100 |
| -227.15 | 242625 | 7181700 | 1421825 |
| -227.10 | 242750 | 7193800 | 1422550 |
| -227.05 | 242875 | 7205900 | 1423275 |
| -227.00 | 243000 | 7218000 | 1424000 |
| -226.95 | 243150 | 7230250 | 1424875 |
| -226.90 | 243300 | 7242500 | 1425750 |
| -226.85 | 243450 | 7254750 | 1426625 |
| -226.80 | 243600 | 7267000 | 1427500 |
| -226.75 | 243750 | 7279250 | 1428375 |
| -226.70 | 243900 | 7291500 | 1429250 |
| -226.65 | 244050 | 7303750 | 1430125 |
| -226.60 | 244200 | 7316000 | 1431000 |
| -226.55 | 244350 | 7328250 | 1431875 |
| -226.50 | 244500 | 7340500 | 1432750 |
| -226.45 | 244650 | 7352750 | 1433625 |
| -226.40 | 244800 | 7365000 | 1434500 |
| -226.35 | 244950 | 7377250 | 1435375 |
| -226.30 | 245100 | 7389500 | 1436250 |
| -226.25 | 245250 | 7401750 | 1437125 |

Exhibit II.7

improvement of agricultural drainage systems caused inflow to exceed evaporation, which has resulted in a gradual and continual rise in the Sea since that time.

Exhibit II.5 is a map of the Salton Sea showing contours and perimeters of the Sea at various periods.

Exhibit II.6 shows the elevation of the Salton Sea since 1904, and also includes a record of elevations at the end of each year.

Exhibit II.7 is a chart showing areas and capacities of the Sea in relation to elevations. In 1907 when the Sea reached its highest level in this century, it covered more than 300,000 acres and contained approximately 15 MAF. of water. In October 1984, the surface area was about 245,000 acres and over 7 MAF of water and silt were in storage.

Exhibit II.8 shows the year-end salinity of waters in the Salton Sea. The current salinity is about 39,500 mg/l which is higher than the average salinity of ocean water...35,000 mg/l. It should be noted that the Great Salt Lake and the Dead Sea both have salinity concentrations of 200,000 mg/l or greater - i.e., 20-percent salt. The importance of the Salton Sea as a repository for agricultural drainage waters has long been recognized. In 1924, a Public Water Reserve was created setting aside public lands lying 244 feet below msl for the purpose of creating a drainage reservoir.

In 1927, the USGS undertook an investigation of the probable future stages of the Sea. It was estimated that 925,000 acres of land in Coachella, Imperial and Mexicali Valleys would be irrigated, with drainage, based on 1.5 acre-feet per acre amounting to 1.387 MAF per year. Storm water inflow to the Sea was assumed to be 500,000 acre-feet per year and evaporation 5.8 feet per year. Based on these assumptions and other important measures, including the provision that the Secretary of Agriculture may establish a voluntary salinity control program with landowners to improve on-farm water management.

This was important and significant legislation and assures continuing efforts to control the salinity of the Colorado River.

7. Salton Sea

The Salton Sea, over 30 miles long and 10-15 miles wide, lies in the lowest portion of the Salton Trough. It is California's largest lake, having a surface area today of about 383 square miles, or 245,000 acres. The Sea receives drainage from an area of 8,360 square miles, including about 1,075 square miles, or 690,000 acres of irrigated lands in Imperial, Coachella and Mexicali Valleys.

The current elevation of the water surface of the Salton Sea is about 227 feet below msl. In 1907, the water surface was 30 feet higher, being 195.9 feet below msl, and the bottom of the Sea was about 278 feet below msl.

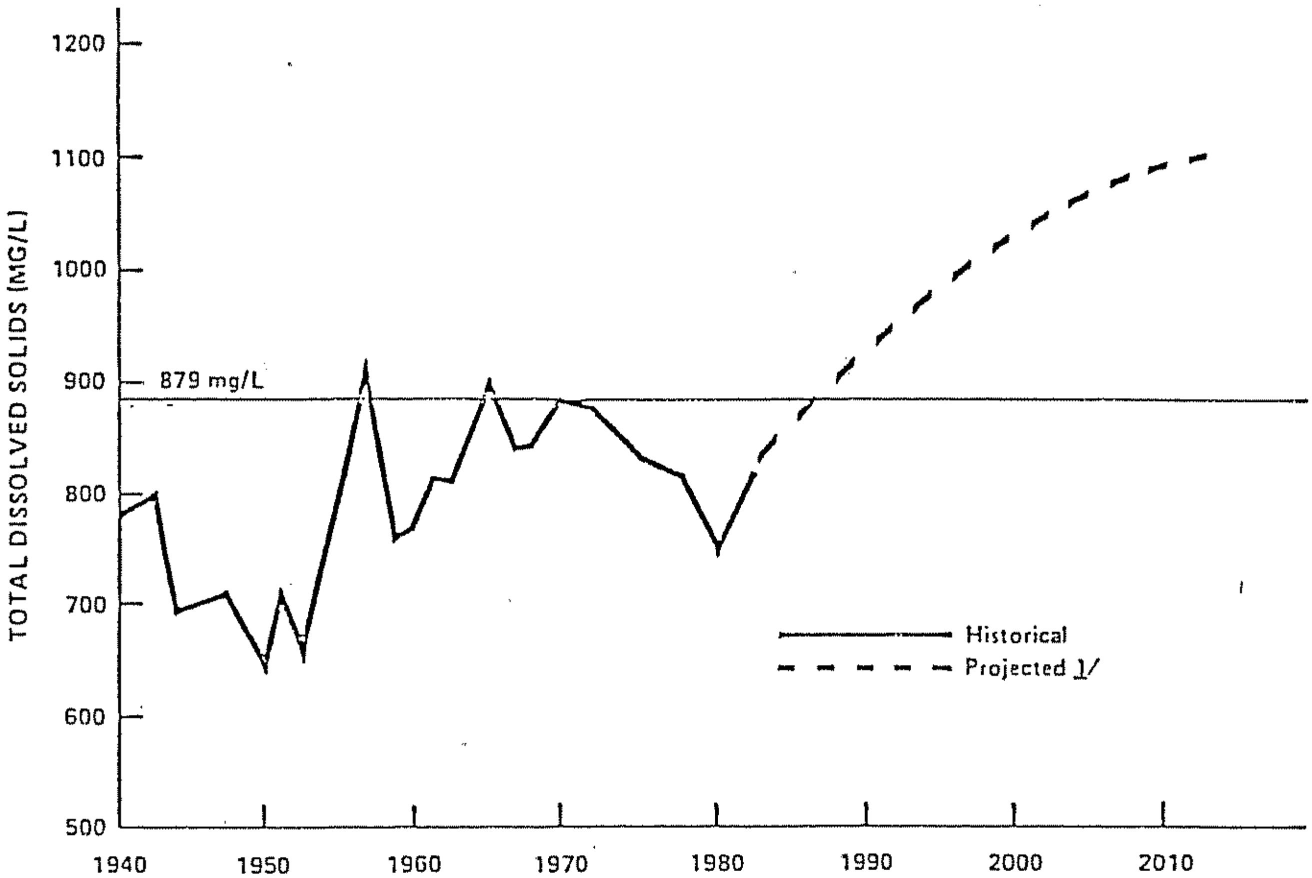
Being within a closed basin, the Sea has no outlet. Evaporation, varying with weather conditions, averages about 71 inches per year and is the only means of disposal or "outflow" from the Sea. Since both inflow and outflow are variable, and result from natural as well as man-made conditions, the water level and area of the Sea change from time to time.

After the Colorado River ceased flowing into the Salton Sea in 1907, evaporation greatly exceeded inflow and the water level rapidly declined until 1924, when increased development of irrigation and salinity problems. The Water Pollution Control Act of 1972 and especially the Colorado River Basin Salinity Control Act of 1974 (Public Law 93-320) established public policy and objectives for water quality management in the basin. The 1972 Act set salinity standards at 1972 levels. The EPA in 1976 set the standard below Parker Dam at 747 ppm and 879 ppm at Imperial Dam. These numerical standards have not been changed to date.

In 1973, Minute 242 of the International Boundary and Water Commission was adopted which provided that the United States agreed to construct a desalination plant at Yuma and other facilities so that waters delivered to Mexico at Morales Dam would have an average annual salinity of not more than 115 ppm, plus or minus 30 ppm, over the annual average salinity at Imperial Dam. The 1974 Act in Title I, authorized construction of the desalting plant and the concrete lining of the Coachella Canal. Title II provided for salinity control projects above Imperial Dam. To meet the salinity standards at Imperial Dam (1972 levels), under future conditions, will require the removal of 2.8 million tons of salt annually from the River system. To date, four units have been authorized for construction: Paradox Valley and Grand Valley (both in Colorado), Crystal Geyser in Utah, and Las Vegas Wash in Nevada. Thirteen additional units are under study. It is estimated that these 17 units will remove about 2 million tons per year. Additional projects may be needed to achieve the goal of 2.8 million tons. Congress passed an amendment to Public Law 93-320 in 1984 authorizing six new projects for Bureau construction and five on-farm programs under the U. S. Department of Agriculture, including the following study projects:

Paradox Valley Unit, Colorado
Grand Valley Unit, Colorado
Las Vegas Wash Unit, Nevada
Stage 1 of Lower Gunnison Basin Unit, Colorado
Portions of McElmo Creek Unit, Colorado

Recorded salinity levels at Imperial Dam with projections through the year 2010.




1/ Without Water Quality Improvement Program

Exhibit II.4

Salinity in the Colorado is the result of erosion of soil and rocks containing high concentrations of mineral salts such as halite, gypsum, and anhydride. Ten elements make up the dissolved solids of the River: hydrogen, sodium, magnesium, potassium, calcium, silicon, chloride, oxygen, carbon, and sulfur. Sodium and chloride ions are the most harmful to crops.

Salinity is a term applying to the lump sum of all the dissolved mineral salts, measured as "total dissolved solids" or "TDS," and expressed in parts per million (ppm) or milligrams per liter (mg/l).

Salinity in the Colorado becomes increasingly higher down the course of the river. It starts out below 50 ppm in the mountain tributaries and has reached between 700 and 900 ppm at Imperial Dam during recent years.

Projections have been made that salinity at Imperial Dam could reach 1,150 ppm by the year 2000. Exhibit II.4 shows recorded and projected levels of salinity, unless corrective action is taken.

The Bureau in 1978 1/ estimated that economic losses in the Colorado River Basin presently average $53 million per year and could more than triple to $165 million by 2000 if no measures are taken. Economic damages to all users at Imperial Dam have been estimated to amount to $300,000 per ppm increase in concentration.

Fortunately, through concerted efforts by the lower basin states, and especially the Colorado River Board of California, federal legislation has been passed with the goal to alleviate some of the

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1/ U.S. Department of the Interior, The Colorado River, Water 9uality Improvement Program (brochure), 1978.

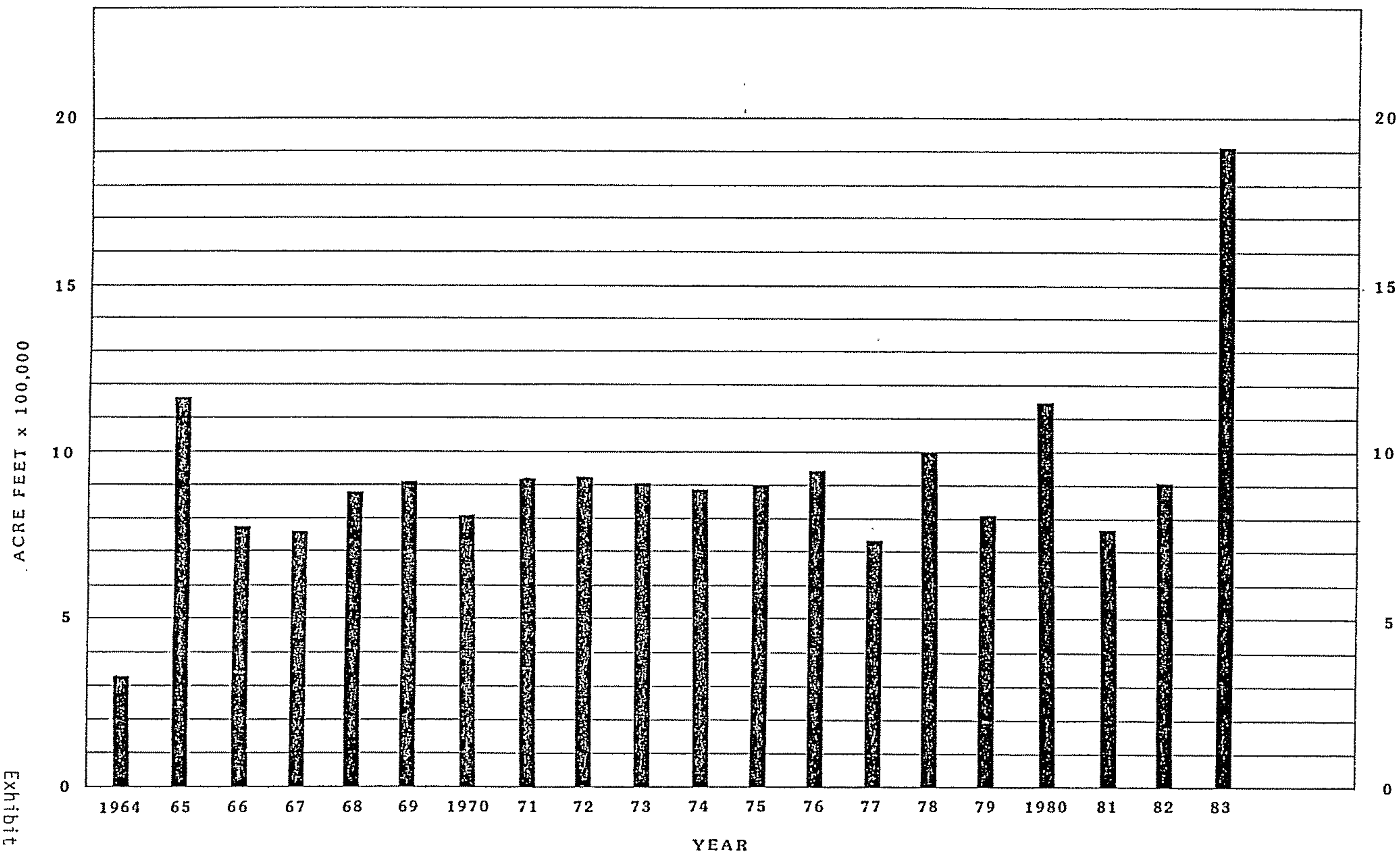
tive decisions. All of the foregoing have resulted in a division or apportionment of the waters of the Colorado River among users thereof or the rights to the "consumptive use" of the Colorado River waters.

It should also be pointed out here that, in the near future, the River will not yield a sufficient supply of water in dry and normal years to meet the increasing demands for its use.

When the Colorado River Compact was signed in 1922, allocations of Colorado River waters were based on runoff records during the two previous decades that would have accommodated 16 MAF in beneficial use annually. However, taking different 20-year periods will result in variations in average runoff (Lee's Ferry) from between 13 and 17 MAF. Table II.2 shows the annual runoff at Lee's Ferry for the period 1964 through 1983, with the average during this period being about 9.1 MAF. Exhibit II.3 shows this information graphically.

Total runoff during 1982-83 was 23.8 MAF at Lee's Ferry, and preliminary data for 1983-84 indicate a new record runoff of nearly 25 MAF, two record years back to back. However, historic records remind us that dry years can be expected to occur. Exhibit II.3 Shows Colorado River Flow at Lee's Ferry for the historic period of record through 1978. It can be seen that about ten years were below 10 MAF, the record low being 5.5 MAF in water year 1977.

Although the Colorado River no longer carries a heavy silt load in its lower reaches, it does carry significant amounts of dissolved salts, and during the past 50 years or so salinity has become an acute problem. It is a problem for domestic users since salts in the water damage plumbing and appliances. But, to agricultural users, it can destroy cropland, and at least reduce crop yields and restrict the choices of crops to be grown.




COLORADO RIVER AT LEE'S FERRY

Exhibit II.3

Table II.2
Colorado River Flow
Lee's Ferry, Arizona

| Year | Acre-Feet |
|---|---|
| 1964 | 3,250,400 |
| 1965 | 11,619,800 |
| 1966 | 7,711,200 |
| 1967 | 7,544,200 |
| 1968 | 8,770,700 |
| 1969 | 9,083,300 |
| 1970 | 8,065,800 |
| 1971 | 9,196,100 |
| 1972 | 9,213,800 |
| 1973 | 9,012,800 |
| 1974 | 8,894,100 |
| 1975 | 8,961,200 |
| 1976 | 9,400,400 |
| 1977 | 7,352,200 |
| 1978 | 8,992,600 |
| 1979 | 8,083,900 |
| 1980 | 11,508,600 |
| 1981 | 7,648,200 |
| 1982 | 9,007,299 |
| 1983 | 19,105,087 |
| Avg. | 9,121,084 |

After the Reclamation Act of 1902, the Yuma Reclamation Project was authorized in 1904. By 1910, the Reclamation Service had built Laguna Dam, Theodore Roosevelt Dam on the Gila in the Lower Basin, and the Uncompahgre and Strawberry Tunnels in Colorado and Utah.

Today, there are eight dams and reservoirs of significance on the Colorado River and its tributaries (excluding dams on Arizona tributaries) providing regulation and about 60 MAF of storage. These are listed below:

| Dam | Location | Storage Capacity (1,000 A.F.) |
|---|---|---|
| Fontelle | Green River | 344 |
| Flaming Gorge | Green River | 3 749 |
| Navajo | San Juan River | 1 696 |
| Morrow Point | Gunnison River | 117 |
| Blue Mesa | Gunnison River | 830 |
| Glen Canyon | Colorado River | 25 000 |
| Hoover | Colorado River | 26 159 |
| Davis | Colorado River | 1 810 |
| Parker | Colorado River | 619 |

"The Law of the River" as applied to the Colorado River, has evolved out of a combination of both federal and state statutes, interstate compacts, court decisions and decrees, contracts with the United States, an international treaty, operating criteria and administra-

Although the River has many tributaries in the Upper Basin, there are very few in the Lower Basin. Below Hoover Dam, there are only two tributaries of any consequence - the Bill Williams River entering Lake Havasu and the Gila River near Yuma, Arizona.

During the early exploration years, the River was called such things as dangerous, unruly, killer, majestic, mighty, etc, but the Spanish explorers named it "Colorado", which means "ruddy" or "nearly red," the color caused by the tremendous silt load once carried by the River. Some said the River was "too thick to drink, too thin to plow" and "not wet, just damp." Since construction and completion of the great dams on the River and its tributaries, beginning with completion of Hoover Dam in 1935, silt has been deposited in Lake Mead and the other reservoirs, and below Lake Mead. The Colorado now runs slate blue in color. Much has been written about this River and its development, so only a brief summary will be given here.

In the Upper Basin, development took place gradually, beginning about 1854 when Mormon settlers of the Green River in southwestern Wyoming began diversions for irrigation, and was hastened by the purchase of land from the Indians in 1873. In the 1880's farmers settled in the Uncompahgre Valley in Colorado. By 1905, about 800,000 acres were being irrigated. By 1920, nearly 1.4 million acres were irrigated, but the increase since then has not been significant and the acreage being irrigated in the Upper Basin today is about 1.6 million acres.

In the Lower Basin, development in the Gila area began in 1875, in 1887 in the Palo Verde Valley, and in the 1890's in the Yuma area. Then in 1901 development began in Imperial Valley, that being the largest undertaking along the River, not only at that time, but to this day.

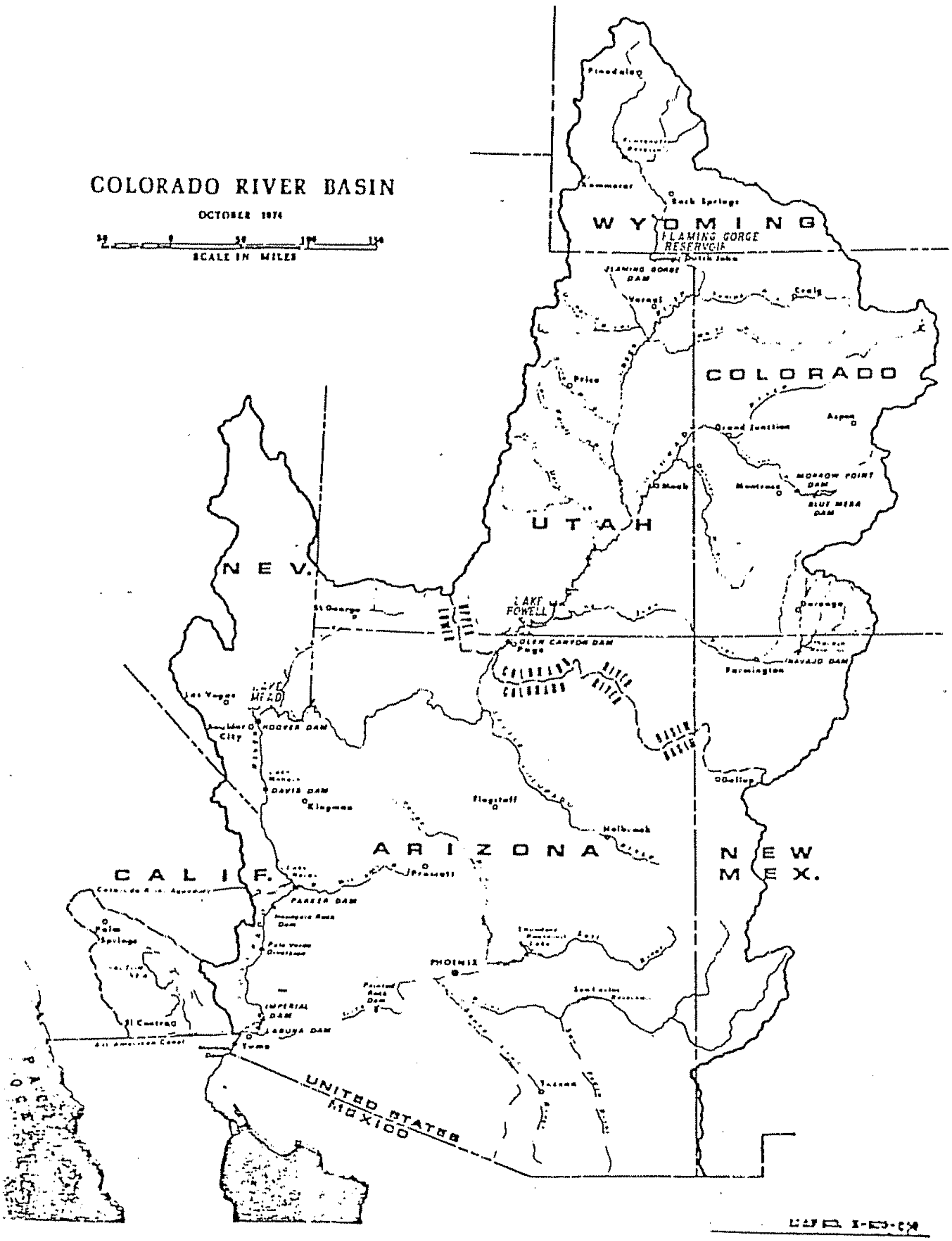

COLORADO RIVER BASIN
OCTOBER 1974
SCALE IN MILES
WYOMING
FLAMING GORGE RESERVOIR
FLAMING GORGE DAM
COLORADO
UTAH
NEV.
LAKE POWELL
GLEN CANYON DAM
LAKE MEAD
HOOVER DAM
DAVIS DAM
ARIZONA
CALIF.
PARKER DAM
IMPERIAL DAM
LAGUNA DAM
PHOENIX
MORROW POINT DAM
BLUE MESA DAM
NAVAJO DAM
NEW MEX.
UNITED STATES
MEXICO
Grand Junction
Las Vegas
Boulder City
Kingman
Flagstaff
Holbrook
Yuma
El Centro
Farmington
Moab
Price
Vernal
Craig
Aspen
Durango
Gallup
Tucson
Rock Springs
Pinedale
Kemmerer
St George
Page
Palm Springs

Exhibit II.2

most practical to reduce storm damage, as well as to store storm waters for beneficial use, is the construction of detention reservoirs above the developed areas of the Valley. These reservoirs could hold runoff for an extended time, thereby making some water available for agriculture or other uses by also allowing evaporation to reduce the inflow into the Salton Sea.

Additionally, certain District drains could be enlarged and armored to convey storm flows to New River in the case of the southwest area and directly to the Salton Sea in the northeast area of the District, especially in and around the towns of Niland and Calipatria, to provide drainage to homes and businesses in these communities. The District intends to investigate these potential projects by working with the U. S. Army Corps of Engineers, county, and state governments.

6. Colorado River

Since the Colorado River is the sole source of water for Imperial Valley, it is important to understand the River to some degree.

The Colorado River originates in the Rocky Mountains, fed by melting snow from these great mountains having many peaks over 14,000 feet. It is the third longest river in America, winding through seven states through deep canyons of the southwest for 1,700 miles toward the Gulf of California in Mexico. Its drainage basin covers about 245,000 square miles, one-twelfth the area of the continental United States. The watershed of the Colorado River is shown in Exhibit II.2.

Winds are normally calm to light throughout much of the year. However, strong northwesterly winds do occur during the spring and fall months. In August, prevailing winds may be from the south or southeast, especially in association with tropical storms.

a. Storms

Imperial Valley is subject to infrequent but sometimes intense storms. In 1976 Tropical Storm Kathleen caused extensive flood damage, which was exceeded in 1977 by the damage from Tropical Storm Doreen.

When rainfall amounts in the Jacumba Mountains to the west and Chocolate Mountains to the east are large enough to produce heavy runoff, large flows run across the Yuha Desert on the West Mesa and spill into the Westside Main Canal causing varying degrees of damage to District canals and drains in the area. Similarly, runoff from the Chocolates flow, partly down Mammoth Wash, and other similar washes north of Calipatria flow from the desert into the agricultural area of the Valley, spilling into the East Highline Canal, often causing considerable damage to the canals and drains in the northeast portion of the District.

Over the years, the District has considered some sort of flood control in these two areas, however, since the canals are unlined earth construction, repair of damage is relatively rapid and inexpensive, even though hundreds of thousands of dollars have been expended over the years to make repairs due to storm damage. The solution usually suggested as being the

Winter (November - February, inclusive) average daily temperatures range between 30 and 89° F. with a mean of about 55° F. Even in January, the coldest month, daytime temperatures usually exceed 75° F. The lowest temperature of record, 16° F., occurred on January 22, 1937. However, hard frosts are uncommon, although nighttime temperatures between 26 and 32° F. are usual for a few days each year.

Besides being among the hottest areas, Imperial Valley is one of the driest spots in the United States. The usual "rainy season" is November through March, but some of the heaviest rains have occurred in August and September resulting from thunderstorms generated by moist air moving north from the waters off the Mexican coast. Tropical storm "Kathleen" in August 1976 dropped 3.87 inches of rain at Imperial and much greater amounts in the surrounding mountains. Then in September 1977 Imperial recorded 2.84 inches of rain from tropical storm "Doreen."

The heaviest rainfall recorded at Imperial since 1914 was 7.08 inches during one week in September 1939. This storm caused extensive flooding throughout Imperial Valley and severe damage to the District's irrigation and drainage systems, as well as farmland and crop damage.

As in the entire desert southwest, the air in Imperial Valley is normally dry. During the summer, relative humidity is frequently below 30 percent being higher in the early morning and dropping sometimes to 20 percent and below as the temperature rises in the afternoon.

equipment worked day and night to repair the damage. The All-American Canal had been completed from the Central Main Canal to the West Side Main Canal, and was put into service to supply the west side of the Valley with water from the Central Main Canal, thus saving probable loss of crops in that area.

The most recent major quake occurred in October 1979, having a magnitude of 6.5. This quake, along the Imperial Fault, caused severe damage to buildings, canal structures, and the All-American Canal, but no lives were lost. Several miles of the All-American Canal were damaged, resulting in a settlement of up to four feet in the embankment. Fortunately, water demand was low at the time, and it was possible to reduce flows sufficiently to continue deliveries to the cities and towns in the Valley for the three or four days it took to rebuild the banks.

5. Climate

Imperial Valley has a typical desert climate with summer daytime temperatures frequently exceeding 100° F. for more than 100 days per year, but with a mild and favorable climate the remainder of the year. Mean annual temperature (1914 to date) is 72.5° F., and average rainfall is 2.91 inches per year.

The highest temperature of 119° has been recorded four times since 1914. Daytime temperatures usually exceed 75° F. Summer (June - September, inclusive) average daily temperature spread is 57.9° F. - 113.8° F. with a mean exceeding 85° during these four months.

TABLE [ ] ; ]ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

| Map symbol | Soil name | Acres | Percent |
|---|---|---|---|
| 100 | Antho loamy fine sand | 4,134 | 0.4 |
| 101 | Antho-Superstition complex | 8,416 | 0.9 |
| 102 | Badland | 4,390 | 0.4 |
| 103 | Carsitas gravelly sand, 0 to 5 percent slopes | 7,011 | 0.7 |
| 104 | Fluvaquents, saline | 12,262 | 1.2 |
| 105 | Glenbar clay loam | 2,951 | 0.3 |
| 106 | Glenbar clay loam, wet | 4,239 | 0.4 |
| 107 | Glenbar complex | 12,894 | 1.3 |
| 108 | Holtville loam | 2,804 | 0.3 |
| 109 | Holtville silty clay | 3,628 | 0.4 |
| 110 | Holtville silty clay, wet | 70,547 | 7.1 |
| 111 | Holtville-Imperial silty clay loams | 2,242 | 0.2 |
| 112 | Imperial silty clay | 1,405 | 0.1 |
| 113 | Imperial silty clay, saline | 5,679 | 0.6 |
| 114 | Imperial silty clay, wet | 123,401 | 12.5 |
| 115 | Imperial-Glenbar silty clay loams, wet, 0 to 2 percent slopes | 203,659 | 20.6 |
| 116 | Imperial-Glenbar silty clay loams, 2 to 5 percent slopes | 2,162 | 0.2 |
| 117 | Indio loam | 9,169 | 0.9 |
| 118 | Indio loam, wet | 13,625 | 1.4 |
| 119 | Indio-Vint complex | 29,643 | 3.0 |
| 120 | Laveen loam | 2,322 | 0.2 |
| 121 | Meloland fine sand | 10,748 | 1.1 |
| 122 | Meloland very fine sandy loam, wet | 41,734 | 4.2 |
| 123 | Meloland and Holtville loams, wet | 11,483 | 1.2 |
| 124 | Niland gravelly sand | 7,884 | 0.8 |
| 125 | Niland gravelly sand, wet | 9,820 | 1.0 |
| 126 | Niland fine sand | 2,846 | 0.3 |
| 127 | Niland loamy fine sand | 2,088 | 0.2 |
| 128 | Niland-Imperial complex, wet | 6,974 | 0.7 |
| 129 | Pits | 1,400 | 0.1 |
| 130 | Rositas sand, 0 to 2 percent slopes | 22,608 | 2.3 |
| 131 | Rositas sand, 2 to 5 percent slopes | 1,590 | 0.2 |
| 132 | Rositas fine sand, 0 to 2 percent slopes | 77,301 | 7.8 |
| 133 | Rositas fine sand, 2 to 9 percent slopes | 40,748 | 4.1 |
| 134 | Rositas fine sand, 9 to 30 percent slopes | 19,401 | 2.0 |
| 135 | Rositas fine sand, wet, 0 to 2 percent slopes | 22,626 | 2.3 |
| 136 | Rositas loamy fine sand, 0 to 2 percent slopes | 90,896 | 9.2 |
| 137 | Rositas silt loam, 0 to 2 percent slopes | 3,737 | 0.4 |
| 138 | Rositas-Superstition loamy fine sands | 11,373 | 1.2 |
| 139 | Superstition loamy fine sand | 12,887 | 1.3 |
| 140 | Torriorthents-Rock outcrop complex, 5 to 60 percent slopes | 462 | * |
| 141 | Torriorthents and Orthids, 5 to 30 percent slopes | 900 | 0.1 |
| 142 | Vint loamy very fine sand, wet | 31,545 | 3.2 |
| 143 | Vint fine sandy loam | 13,066 | 1.3 |
| 144 | Vint and Indio very fine sandy loams, wet | 15,462 | 1.6 |
| | Water | 3,288 | 0.3 |
| | Total | 989,450 | 100.0 |

* Less than 0.1 percent.

The survey also contains a table showing all of the soil types identified, reproduced herein as Table II.1. From this information, it is apparent that the following three soils series dominate in the developed area of the Valley:

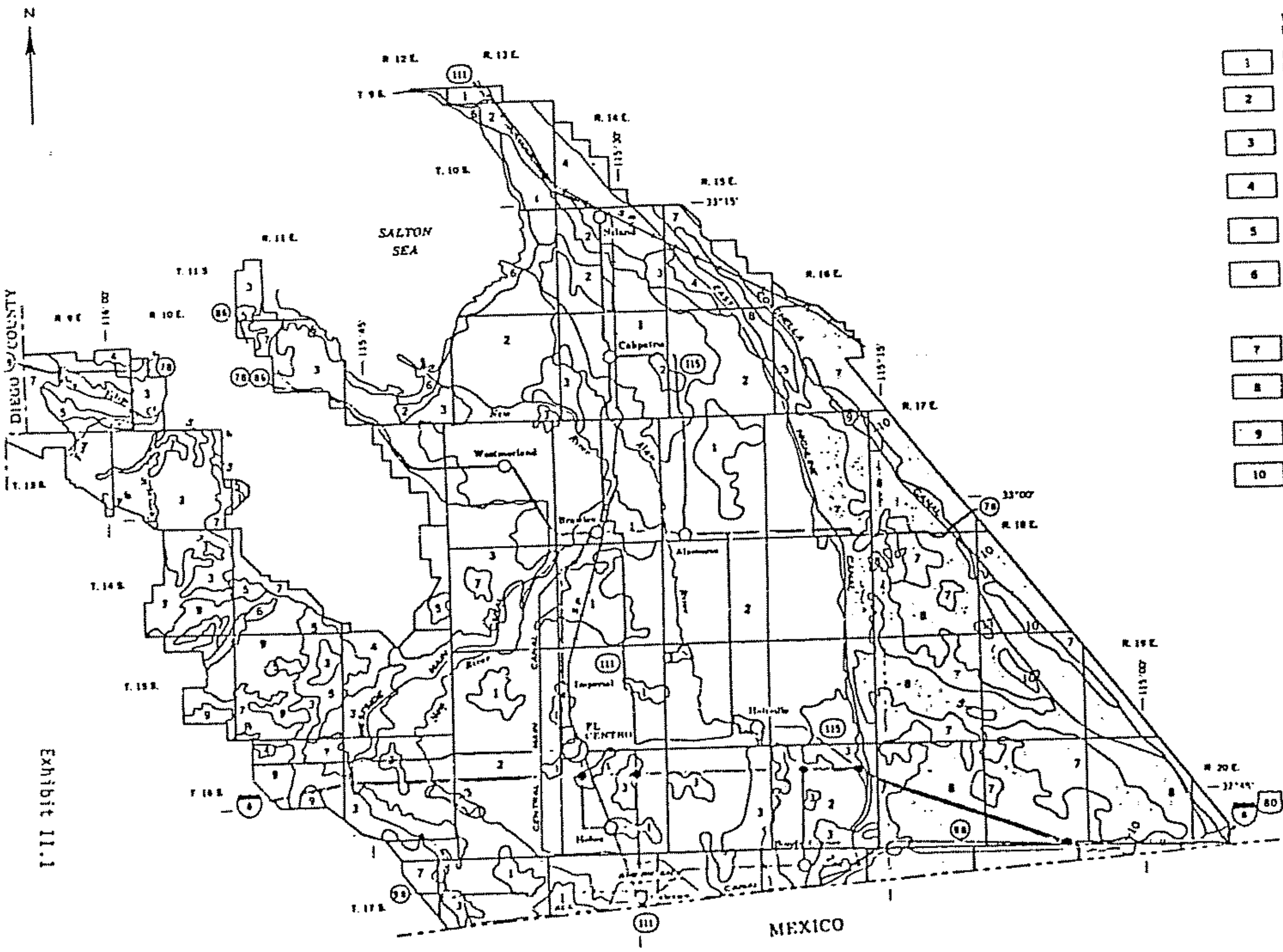
Imperial - over 300,000 acres
Holtville - about 80,000 acres
Meloland - about 40,000 acres

4. Seismicity

Numerous earthquake faults, many of them active, traverse Imperial Valley and the Salton Trough. The most noteworthy fault is the San Andreas which extends from Mexico to Northern California.

More than 60 earthquakes of Richter Scale magnitude 5.0 and greater have been recorded in the Salton Trough area since 1900. Hundreds of small quakes have been recorded. The largest recorded quake registering 7.1 on the Richter Scale occurred in May 1940 along the San Jacinto Fault. The epicenter was located east of Calexico on the International Border. The fault could be traced for nearly 50 miles from Volcano Lake in Mexico extending through the Valley to north of Brawley. A horizontal movement of over 14 feet was observed across the newly completed All-American Canal.

Several lives were lost as severe damage occurred in most of the towns in the Valley. The quake caused extensive damage to the District's canals and drains, the major impact being along the canal system in Mexico where several miles of the Solfatara Canal were completely destroyed, and the large flume across New River was wrecked beyond repair. The entire water supply to the District's system had to be cut off for several days. District forces and




## MAP UNITS*

WELL DRAINED TO POORLY DRAINED SOILS DOMINANTLY IN THE LACUSTRINE BASIN

**1** Imperial: Nearly level, moderately well drained silty clay in the lacustrine basin

**2** Imperial-Holtville-Glenbar: Nearly level, moderately well drained and well drained silty clay, silty clay loam, and clay loam in the lacustrine basin

**3** Meloland-Vint-Indio: Nearly level, well drained fine sand, loamy very fine sand, fine sandy loam, very fine sandy loam, loam, and silt loam in the lacustrine basin and on low alluvial fans

**4** Niland-Imperial: Nearly level, moderately well drained gravelly sand, fine sand, silty clay, and silty clay loam at the edges of the lacustrine basin

**5** Glenbar-Imperial: Nearly level, well drained and moderately well drained silt loam, clay loam, silty clay loam, sand, fine sand, and silty clay dominantly in basins on West Mesa

**6** Fluvaquents: Nearly level, poorly drained soils of undifferentiated texture in the lacustrine basin

WELL DRAINED AND SOMEWHAT EXCESSIVELY DRAINED SOILS DOMINANTLY ON EAST MESA AND ON WEST MESA

**7** Rositas: Nearly level to moderately steep, somewhat excessively drained sand, fine sand, and silt loam in alluvial basins and on fans and sand [illegible]

**8** Rositas-Superstition: Nearly level, somewhat excessively drained loamy fine sand or fine sand on alluvial terraces and fans

**9** Antho-Superstition-Rositas: Nearly level, well drained and somewhat excessively drained fine sand and loamy fine sand in alluvial basins and on alluvial fans and terraces

**10** Holtville-Antho: Nearly level, well drained loamy fine sand, loam, silty clay loam, and silty clay on alluvial terraces

*Texture refers to surface layer

Compiled 1979

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
UNIVERSITY OF CALIFORNIA AGRICULTURAL EXPERIMENT STA

# GENERAL SOIL MAP
## IMPERIAL COUNTY, CALIFORNIA
## IMPERIAL VALLEY AREA

Scale 1:443,520

1 0 1 2 3 4 5 6 7 MILES

Exhibit II.1

Cooperative Soil Survey, and dated October 1981. A General Soil Map contained therein identifies six major soil types which predominate in the developed lacustrine basin portion of Imperial Valley, the 500,000 acres served by the District. It is a broad perspective and not intended to show the detail necessary for planning the management of a farm or field.

The six broad soil types are described on the General Soil Map, Exhibit II.1, as follows:

1. Imperial: Nearly level, moderately well drained silty clay in the lacustrine basin;

2. Imperial-Holtville-Glenbar: Nearly level, moderately well drained and well drained silty clay, silty clay loam, and clay loam in the lacustrine basin;

3. Meloland-Vint-Indio: Nearly level, well drained fine sand, loamy very fine sand, fine sandy loam, and silt loam in the lacustrine basin and on low alluvial fans;

4. Niland-Imperial: Nearly level, moderately well drained gravelly sand, fine sand, silty clay, and silty clay loam at the edges of the lacustrine basin;

5. Glenbar-Imperial: Nearly level, well drained and moderately well drained silt loam, clay loam, silty clay loam, sand, fine sand, and silty clay dominantly in basins on West Mesa.

The Laguna Mountains and other mountains which are part of the California Coast Range to the west of the valley reach elevations over 4,000 feet. The Chocolate Mountains to the east are not as high, being about 2,000 feet at the highest.

North of the Salton Sea several other mountain ranges containing the highest peaks in Southern California, over 10,000 feet, close in the Salton Sink, as the area was once known. The total watershed tributary to Salton Sea contains about 8,360 square miles.

3. Soils

Imperial Valley contains relatively recent deposits of water transported soil. The central, irrigated area served by the District generally lies below sea level, and has fine-textured silts rather than sands usually associated with desert areas. Above mean sea level (msl) within the East and West Mesas, sandy soils predominate, typical of most of the deserts in the southwest United States. Furthermore, there is no "top soil" in the usual sense, nor do any well-defined horizons exist. Instead of being several inches, the soils are thousands of feet deep.

Generally, the soils are highly variable and complex, i.e., heterogeneous. The upper soil profile, prior to development, has been reworked by flooding of New and Alamo Rivers and numerous washes from the East and West Mesas. Surface soils have also been reworked by wind erosion.

The most recent soil survey for Imperial Valley was conducted between 1962 and 1975 by the joint efforts of federal, state, and local agencies, and reported in "Soil Survey of Imperial County, California, Imperial Valley Area," published by the National

Gradually the delta extended itself for hundreds of miles southerly into the Gulf of California and westerly and northerly through the Mexicali Valley and into the Imperial Valley. It is not known how deep the river silt is in Imperial Valley; it has a depth of as much as 2,000 feet in places.

The central developed portion of Imperial Valley is a relatively flat plain, sloping from mean sea level (msl) at the Mexican border to about 226 feet below msl at the edge of the present Salton Sea. The bottom of the Salton Sea, estimated to be over more than 270 feet below mean sea level (msl), is one of the lowest points in North America. The eastern portion of Imperial Valley known as the East Mesa is a broad expanse of raw desert sloping gently east to west. Similarly, the West Mesa slopes west to east toward the cultivated area of the Valley.

The Colorado River flows north to south through the Colorado Desert forming the California-Arizona border and at Imperial Dam is about 180 feet above msl. The elevation near Yuma, Arizona is about 150 feet. The River channel continues southerly along the crest of its delta through Mexico to the Gulf of California.

South of Imperial Valley in Mexico, the Colorado River delta contains a broad ridge or saddle running southwesterly from Algodones (near Yuma, Arizona) to Cierro Prieto, Mexico, at which point the ground elevation is about 40 feet above msl. North and west of this saddle, runoff and drainage flow through the Mexicali and Imperial Valleys toward the Salton Sea. South and east, drainage is into the Gulf of California.

The gross area of the District is 1,062,290 acres, with about 465,000 acres in the central part of the District - termed "Imperial Unit" - being irrigated, although slightly over 500,000 acres of land receive water when cities, towns, recreation and other non-agricultural users are included.

Imperial Valley contains nine cities and towns. El Centro, the County Seat with a 1984 population of about 26,000, is located in the southwestern part of the District about 60 miles west of Yuma, Arizona, and 120 miles east of San Diego, California. Brawley, the second largest city, lies about 14 miles north of El Centro, and Calexico, next largest, 10 miles southeast of El Centro on the Mexican border.

2. Topography

The flatness of the Imperial Valley defies its extremely active present and past geology. Several million years ago it was part of an inland sea which included the present Gulf of California and extended through the Imperial and Coachella Valleys north through the San Joaquin and Sacramento Valleys and beyond. There followed a tremendous upthrust, which was the birth of the mountain ranges seen around the Imperial Valley, and the entire area emerged from the sea.

There was a gradual settling of the central portion of the area now occupied by the Imperial and Coachella Valleys. The Colorado River began disgorging its silt into the area, depositing silt eroded from the 240,000 square miles of its drainage area, including the Grand Canyon.

# CHAPTER II

## BACKGROUND

### A. GEOGRAPHICAL SETTING

Described herein are some of the important geographical features of the Imperial Valley which provide a basis for an understanding of the District's water system.

#### 1. Location

The Imperial Valley is located in the southeast corner of California. Arizona borders on the east and Mexico on the south. Originally part of what was known as the Colorado Desert, this area is composed of about 6,000 square miles of sand, silt and sagebrush. Adjacent mountains to the northwest reach elevations of 10,000 feet. The desert extends southeasterly some 200 miles through the Coachella Valley, Imperial Valley and Mexicali Valley to the Gulf of California. It is bounded on the east by the Colorado River. The Imperial Irrigation District is located in the geographical center of this area within the Imperial Valley.

The Valley consists of the southern end of the depression known as the Salton Basin. This basin was formed by a gradual depression of the area by block faulting, while at the same time encroachment of the Colorado River Delta from the east and south covered the area with sediments originating in the several states comprising the Colorado River Watershed. Most of the irrigated land in the Valley is below sea level. The lowest lands border the Salton Sea at an elevation of 235 feet below sea level.

TABLE I.3

WATER USE IN CITY OF LOS ANGELES

| | | : Amounts |
|---|---|---|
| Production | | |
| Los Angeles Aqueduct(1) | 476,000AF | |
| MWD(1) | 46,000AF | |
| Local Wells(1) | 95,000AF | 617,000AF |
| Sales(1) | | 565,000AF |
| Losses | | 52,000AF |
| Losses in percent of Production | | 8.4% |
| Sewage (over 99% to Ocean)(2) | | 305,000AF |
| Sewage in percent of Sales | | 54% |
| Consumptive Use - (75% of outside use) | | 195,000AF |
| Conveyance System Efficiency | $\frac{565,000}{617,000} = 91.6\%$ | |
| Efficiency of Use | $\frac{195,000}{565,000} = 34.5\%$ | |
| Overall Efficiency | 31.6% | |

(1) LADWP Statistical Reports for 1980-81 fiscal year.
(2) 54% of sales based on data for SC area in DWR Bulletin 160-74.

6. Comparison with Municipal Use

A comparison of agricultural use can be made with that of municipal and domestic use. The same principles apply including import, conveyance losses, deliveries and used water (sewage).

For an example, the water supply for the City of Los Angeles is shown in Table I.3. Data is for the 1980-81 fiscal year. The City of Los Angeles has a 91.6 percent conveyance system efficiency. A small part of the loss is reservoir evaporation. The majority of the loss includes meter discrepancies, reservoir seepage, main leaks, and other minor uses and losses.

Relating sales to consumptive use as a measure of efficiency (the same measure as used for agriculture) indicates an efficiency of use of 34.5 percent, but the overall efficiency for Los Angeles is 31.6 percent.

The estimated sewage flow from the City of Los Angeles is about 54 percent of sales (applied water). This could be related to leaching in the Imperial Valley which is on the order of 15 percent of delivered water. It is also noted that currently well over 99 percent of the sewage generated in the City of Los Angeles is delivered to the Pacific Ocean.

This comparison illustrates that the efficiencies within IID are comparable to urban areas when considering conveyance efficiency and exceedingly high when considering overall efficiency.

The relative efficiencies illustrate only that efficiencies are related to the specific use and are not a sole measure of effective use.

water-intake rates and fields that slope toward the Salton Sea result in most excess water from field applications finding its way to the Sea in the form of surface runoff and spills rather than in unseen deep percolation such as occurs in districts with coarser textured soils.

A comparison of delivery efficiencies of most of the Lower Colorado agencies is given in Table I.1. All have lower efficiencies than IID.

5. I.I.D. Irrigation Efficiency

Despite the unusual and unfavorable characteristics for ease of operation as heretofore cited, the District has perfected a system of estimating its water needs; placing its orders for diversions from Imperial Dam; and delivering water to its water users that has resulted in the District having one of the highest (1) conveyance efficiencies, (2) on-farm irrigation efficiencies; and (3) overall project irrigation efficiencies of all gravity irrigated projects in the United States.

Bookman-Edmonston prepared a summary sheet on "Efficiency of Water Conveyance and On-Farm Irrigation" which is attached as Table I.2. It shows that the annual efficiencies of conveyance averaged 91 percent for the four-year period. The annual on-farm irrigation efficiencies during the same period averaged 72 percent. Overall District irrigation efficiencies averaged 66 percent for the four-year period.

TABLE I.2

EFFICIENCY OF WATER CONVEYANCE AND ON-FARM IRRIGATION
IMPERIAL IRRIGATION DISTRICT, CALIFORNIA
1977 - 1980

| | Amounts |
|---|---|
| Acres Irrigated | 460,000 |
| Diversions Below Drop No. 1 (acre-feet) | 2,734,000 |
| Diversions per acre irrigated (acre-feet) | 5.94 |
| Delivered to farms (total acre-feet) | 2,496,500 |
| Conveyance System Efficiency (in %) | 91 |
| On-Farm Consumptive Use (total acre-feet) | 1,797,000 |
| On-Farm Consumptive Use (acre-feet per acre) | 3.90 |
| On-Farm Irrigation Efficiency (in %) | 72 |
| District Irrigation Efficiency (in %) | 66 |
| Leaching Requirements (acre-feet) | 270,000 |
| Unit Irrigation Efficiency (in %) | 83 |

length of time, the sum of which will yield the total quantity of water desired. For example, on the nearby Yuma Mesa Irrigation and Drainage District and Wellton-Mohawk Irrigation and Drainage District in Arizona, deliveries are made largely in units of 15-16 cfs and the time of irrigation varied accordingly.

In the Imperial Irrigation District, the time is fixed in 24-hour units and the rate of flow varied to match the total quantity of water desired. In other words, the only difference in the system of ordering water in IID and other districts in the Lower Colorado River area is that IID holds the time in constant units (24 hours) and varies the rate of delivery (cfs) while other districts tend to hold the rate of delivery in constant units and vary the time.

In each district in the Western United States, the system used for water users scheduling water orders has been developed around (1) the design of the project conveyance and distribution system in relation to the source and quantity of water supply; (2) quantity of water service the water users want and can afford; (3) the local characteristics of soils, topography, drainage, and cropping patterns. In the case of IID, those characteristics are rather unusual. As pointed out heretofore, the District's distribution system and on-farm development predated the construction of major storage and diversion works of the Colorado River and the delivery of silt-free water. It takes five days for water releases from Lake Mead storage to reach Imperial Dam and another day or more for the water delivered to the District at Imperial Dam to reach most of the water users. Imperial Valley's agriculture involves high-cost and high-risk crops (i.e., lettuce, cabbage, tomatoes, onions, etc.) in which a shortage of water at critical periods can be disastrous. Therefore, a high level of service and reliability of water is a must. The land characteristics of fine-textured soils with low

It must be emphasized that each irrigation serves the basic purpose of replenishing the moisture that has been extracted from the soil by evapotranspiration. Any water applied in excess of this amount will eventually find its way to the Alamo or New River or directly to the Salton Sea through (1) runoff from the lower end of the farmer's fields; (2) as deep percolation drainage water; or (3) as spillwater from canals or laterals if deliveries to farmers are discontinued early and no other water users can take the excess water.

The farmers place their order for water one to three days in advance and the District places its order on Wednesday for the block of deliveries the following week starting Monday. Any daily changes must be made three days in advance in 24-hour increments. Similarly, the Imperial Dam Supervisor places orders for releases of upstream storage.

### 4. Irrigation Procedures in Other Western Areas

Water users on irrigation projects in the Western United States employ many different systems of placing water orders with irrigation districts. For efficient irrigation, an irrigator must know the depth of water needed to replenish the water that has been extracted from the root zone by plants and evaporation. Second, he must decide whether he is going to include additional water in each irrigation for salt leaching or whether that is to be accomplished by separate irrigations (often preplanting).

Once the depth of the water needed is determined and the acreage to be irrigated is known, it is a simple matter to calculate the total acre-inches or acre-feet of water for an order. Depending on the design of each district's system and its method of operation, a water user places an order combining; (1) a rate of flow; (2) a weeds in the District's distribution system. Such growth can be controlled best by drying up the distribution canals and laterals about once a month.

The climate, soils, and land ownership pattern in the District lends itself to intensive commercial agriculture with relatively few small or part-time farming operations. As a result, there is little need for small or short-time irrigation water orders.

The general characteristic of the District's irrigation distribution system continues to be one that has limited water storage capacity in the canals; the water elevation in some canals has to be raised by the use of check gates so as to deliver adequate streams of water to farmers' headgates; and some canals can be drained for maintenance and so-called moss control only by emptying them into spillways or drains when so-called "run-down" water cannot be delivered to water users.

3. On-Farm Operations

Farm ditches and irrigated lands generally slope toward the Salton Sea. This, along with the low infiltraion rate of the fine-textured clay soils which dominate the Valley, make it difficult to irrigate most crops without some runoff ("tailwater") from the low end of the field. Fortunately, the fine-textured soils have a high water-holding capacity so that if an irrigator has irrigated an entire field before the end of his 24-hour water order, he is often able to "reirrigate" part of the land without losing excess water by deep percolation. As Colorado River water is relatively high in total dissolved solids (TDS), some downward percolation of water beyond the root zone is necessary to avoid accumulation of excess salt in the root zone after evapotranspiration, and such "reirrigation" may provide beneficial leaching.

## G. WATER USE EFFICIENCY

### 1. General

Efficiency of water use can be defined by different terms. The terms commonly used, and as used in this report, are given in "Definitions".

The operations of the District which affect the conveyance system efficiency and also on-farm operations, are discussed herein.

### 2. Operational Considerations

The District's operational procedures and its water users' on-farm irrigation practices relate closely to the history of irrigation development in the Imperial Valley. Physical arrangements for diversion of water from the Colorado River were made entirely by private enterprise. Land leveling for irrigation on farms was almost totally by horse drawn scrapers and wooden floats.

The result is that most of the irrigation canals and laterals, and the on-farm ditches and leveling of fields are constructed to fit the general contour of the land which slopes toward the Salton Sea. Once the District distribution system and on-farm developments were in operation, it became extremely difficult to make major changes because of the year-round cropping and irrigation.

Construction of Imperial Dam and the All-American Canal made little change in the irrigation distribution system within the Valley. From an operation and maintenance standpoint, water delivered through the All-American Canal system is more silt free than prior waters, thereby resulting in more growth of moss, algae and aquatic

In 1978, the Supreme Court in California v. United States, 438 U.S. 645, held that the "history of the relationship between the federal government and the states and the reclamation of the arid lands of the western states is both long and involved, but through it runs the consistent thread of purposeful and continued deference to state water law by Congress." In Bryant v. Yellen (1980) 447 U.S. at 355, the court held that the Boulder Canyon Project Act "...was supplemental to the reclamation laws ... [and] required the Secretary of Interior [to] observe rights to Colorado River water that had been perfected under state law ...." The court further held that "...state law was not displaced by the Project Act and must be consulted in determining the content and characteristics of the [state law perfected] water right that was adjudicated to [IID] by our decree." Id. 447 U.S. at 371.

Finally, the California Supreme Court has held that state water provisions are valid so long as they are not inconsistent with congressional directive. See Environmental Defense Fund v. East Bay Municipal Utility District (1979) 26 Cal. 3d 183.

In conclusion, state law appears to be consistent with federal directives pertaining to Imperial Irrigation Distict's water rights and allows the District to voluntarily transfer conserved water to other California users.

Water Code Section 109 declares it to be "the established policy of this state to facilitate the voluntary transfer of water and water rights where consistent with the public welfare of the place of export and the place of import." In addition, Water Code section 1244 provides that:

> "A sale ... shall not constitute evidence of waste ... [nor] any determination of forfeiture [of] water appropriated prior to December 19, 1914."

Further, assuming a transfer of water would involve a change in the point of the District's diversion, Water Code Section 1706 appears to apply. It would allow the District, being a pre-1914 appropriator, to "change the point of diversion, place of use, or purpose of use if others are not injured by such a change ...."

Water Code Section 22259 authorizes the District's Board to "... enter into a contract for the lease or sale of any surplus water or use of surplus water not then necessary for use within the District, for use either within or without the District."

Finally, Water Code Section 1012 specifically protects Imperial Irrigation District against a forfeiture in the event the District transfers conserved water.

In addition to the decrees in Arizona v. California, recent U.S. Supreme Court cases reaffirm that state water provisions should be respected so long as they do not conflict with federal law.

pursuance of Article VIII of said Colorado River Compact." (See Section 6 of the Project Act.) The Seven Party Water Agreement between the California users applies to water delivered pursuant to the Colorado River Compact and the Boulder Canyon Project Act, not to present perfected rights, because those rights are unimpaired by the Compact, by the Project Act, and by the Seven Party Agreement.

Finally, the All-American Canal Contract between the United States and the Imperial Irrigation District provides that the delivery of water as a result of the Boulder Canyon Project Act is "subject to the terms of the Colorado River Compact." (See Section 2.) The contract is subject to the satisfaction of present perfected rights and is without prejudice to any other or additonal rights which the District has. (See Section 17.)

Accordingly, the District's present perfected rights are fully recognized and protected by virtue of the United states Supreme Court Decree and Supplemental Decree in Arizona v. California and are not subject to any use limitations contained in the Compact, the Boulder Canyon Project Act, or the Seven Party Agreement.

The District's present perfected rights, having been acquired pursuant to state law, may be conserved and thereafter "may be sold,leased, exchanged, or otherwise transferred ...." and the reduction in use resulting from conservation efforts "shall be deemed equivalent to a reasonable beneficial use of water to the extent of such cessation or reduction in use ...." (Water Code Section 1011)

Section 2 of the 1964 Decree in Arizona v. California provides that the United States is enjoined from operating the dam other than "(1) for River regulation, improvement of navigation, and flood control; (2) for irrigation and domestic uses, including the satisfaction of present perfected rights; and (3) for power." In the 1979 Supplemental Decree, IID's present perfected right is defined, in part, as "water necessary to supply the consumptive use required for irrigation of 424,145 acres and for the satisfaction of related uses ...."

Land within the boundaries of the Imperial Irrigation District is not entitled to any particular quantity of water, but, is entitled to the amount that can be put to beneficial use. All lands within the District have equal water rights. In times of shortage, the quantity available is prorated to all lands based upon the assessed valuation of each parcel and the total asessed valuation of all parcels.

b. Use of Water Outside of District Boundaries

Conserved or surplus water, which is a portion of water appropriated by the district pursuant to state law, may be used outside of the District boundaries if the District's Board of Directors finds it to be for the best interests of the District.

As stated above, present perfected rights are water rights "acquired in accordance with state law." The Colorado River Compact does not impair these rights (see Article VIII). Additionally, the Boulder Canyon Project Act is suject to the terms of the Compact and specifically provides that the Project shall be utilized for "satisfaction of present perfected rights in the Imperial or Coachella Valleys." Section 4 limits California to 4.4 million acre-feet "including all uses under contracts made under the provisions of this Act and all water necessary for the supply of any rights which may now exist."

In Section 5, the Secretary of Interior is authorized to contract for the delivery of water "at such points on the River and on said Canal as may be agreed upon for irrigation and domestic uses shall be for permanent service." In section 6, it is provided that the dam and reservoir shall be used "for irrigation and domestic uses and satisfaction of present perfected rights."

The All-American Canal Contract contains several references to the use of water within the District. As set forth in Article 17, the United States is required to deliver to the Imperial Irrigation District water which is available for use in California under the Colorado River Compact and the Boulder Canyon Project Act. The District's allotment is included within the third priority which is for the beneficial consumptive use of not more than 3,850,000 acre-feet in the first three priorities. Section 17 also provides that water shall be delivered as ordered by the District "and as reasonably required for potable and irrigation purposes." This section provides that the contract is for permanent service and that the dam and reservoir shall be used "for irrigation and domestic uses and satisfaction of present perfected rights."

Finally, Article 29 of the contract specifically provides that "all rights based upon this contract shall be subject to and controlled by the Colorado River Compact."

7. <u>Use of Water</u>

a. Use of Water Within the District

Water diverted by the District pursuant to its present perfected rights or contractual rights can be used for domestic and agricultural purposes. The Colorado River Compact, the foundational document for "the law of the River," apportions in perpetuity to the lower Basin all water necessary for application to "domestic and agricultural uses." The term "domestic use" is defined in Article II (h) of the Compact as follows:

> "The term 'domestic use' shall include the use of water for household, stock, municipal, mining, milling, industrial, or other like purposes ...."

Further, Article IV (b) provides that Colorado River water may be impounded and used for the generation of electrical power, "but such impounding and use shall be subservient to the use and consumption of such water for agricultural and domestic purposes and shall not interfer with or prevent use for such dominent purposes."

The Boulder Canyon Project Act contains a number of references which are helpful when read in conjunction with the Colorado River Compact. Section 1 of the Act recites that the purpose of the Act is "for storage and for the delivery of the stored waters thereof for reclamation of public lands and other beneficial uses ...." Also, in Section 1, it is provided that "no charge shall be made for water or for the use, storage or delivery of water for irrigation or water for potable purposes in

5. 1934 Compromise Agreement

After execution of the Seven Party Agreement, a draft contract for water delivery was submitted to the District by the Secretary of Interior. This draft contemplated that the Imperial Irrigation District would extend its boundaries to include the area in Coachella Valley. The people in Coachella Valley desired to maintain their own organization and the District negotiated another contract with the Secretary of Interior which was adopted by the District and approved by the voters. Following approval, the District filed an action in the Superior Court for the validation of the contract. Conchella, appearing through individual property owners, objected to the validation of the contract. Following judgment in favor of the District and during Coachella's appeal, negotiations were carried on between Imperial and Coachella which resulted in an Agreement of Compromise dated February 14, 1934. As a result of this Agreement, in times of shortage, the Imperial Irrigation District has priority over Coachella.

6. Contractual Rights

As set forth above, the District has certain contractual rights with the United States pursuant to a described priority agreement. Pursuant to the All-American Canal Contract, and the Seven Party Agreement, the IID and Coachella, along with Palo Verde and the Yuma Project, are entitled to divert 3.85 million acre-feet annually. At the time the Central Arizona Project begins its diversions, Metropolitan Water district will be limited to a maximum of 550,000 acre-feet. Acccordingly, in times of normal flow, the balance of the priorities cannot be satisfied.

Act which provided that the dam and reseroir authorized by the Act should be used for specific purposes including "satisfaction of present perfected rights in pursuance of Article VIII of the Colorado River Compact."

The term was not defined until the Supreme Court's decree in Arizona v. California in 1964. There it was defined as a water right acquired in accordance with state law which right had been exercised by the actual diversion of a specific quantity of water that has been applied to a defined area of land or to definite municipal or industrial works and existing as of June 25, 1929, the effective date of the Act. The District's present perfected right was set at 2,600,000 acre-feet annually because that was the annual quantity being diverted by II on June 25, 1929, and was actually being used on the 424,145 acres then being irrigated. These vested rights predate the Reclamation Law of 1902 and are not subject to reclamation law limitations. See Bryant v. Yellen (1980) 447 U.S. 352.

One significance of the District's present perfected rights is that in times of shortage, present perfected rights must be satisfied first. Of the users described in the Seven Party Agreement, only Palo Verde Irrigation District, Imperial Irrigation District, and the Reservation Division, Yuma Project California (non-Indian portion) have present perfected rights. (Metropolitan Water District, Coachella, and the other users do not have present perrfected rights.) Palo Verde is limited to 219,780 acre-feet or the quantity of mainstream water necessary to supply the consumptive use required for irigation of 33,604 acres. The Yuma Project (Reservation Division) is entitled to 38,270 acre-feet of diversions or the quantity of mainstream water necessary to supply the consumptive use required for irrigation of 6,294 acres.

Note that the first four California priorities total 4.4 million acre-feet annually, of which the agricultural agencies ae entitled to 3.85 million acre-feet. As a result of the Colorado River Basin Project Act (September 30, 1968), the 4.4 million acre-feet is also the quantity accorded a priority over the Central Arizona Project.

4. IID's Water Rights

With this brief background, a review of Imperial Valley's existing water rights is now discussed. First, the District claims appropriative water rights by virtue of its Aplications an Permits issued by the State of California. These right are supplementary and subservient to the District's other appropriative rights. Secondly, as disussed above, the District has contractual rights by virtue of the Boulder Canyon Project Act and the All-American Canal Contract which incorporated the priorities of the California Seven Party Agreement. Finally, and most importantly, as a result of the appropriations made between 1895 and 1899, the District has present perfected rights to the beneficial use of the waters of the Colorado River system. While the District's present perfected rights may be included in the actual quantity of water to be delivered pursuant to its contract with the Secretary of Interior, the legal and practical significance of the District's present perfected rights must not be underestimated.

Present Perfected Rights: In order to fully explain the District's water rights, it is important to understand the true nature of present perfected rights. The term was first used in the Colorado River Compact which provided "present perfected rights to the beneficial use of waters of the Colorado River system are unimpaired by the Compact." The term is also found in the Boulder Canyon Project

| Priority | | | |
|---|---|---|---|
| 1. | Palo Verde Irrigation District (For use exclusively upon 104,500 acres of land in and adjoining district | 3.85 MAF total | 4.40 MAF |
| 2. | Yuma Project (For use on California Division, not exceeding 25,000 acres of land | | |
| 3a. | Imperial Irrigation District & Coachella Valley County Water District (Lands served by All-American Canal in Imperial and Coachella Valleys | | |
| 3b. | Palo Verde Irrigation District (For use exclusively on an additional 16,000 acres of land | | |
| 4. | Metropolitan Water District (For use on S. Cal. Coastal Plain | 0.55 MAF | |
| 5a. | Metropolitan Water District (For use on S. Cal. Coastal Plain | 0.55 MAF | |
| 5b. | City and County of San Diego | 0.112 MAF | |
| 6a. | IID and CVWD | 0.3 MAF | |
| 6b. | Palo Verde Irrigation District (For an additional 16,000 acres) | | |
| TOTAL ALLOCATIONS WITHIN CALIFORNIA | | 5.362 MAF | |

In addition, the Project Act required the Imperial Irrigtion District, and other water users, to enter into water delivery contracts with the Secretary of Interior. Finally, the Act provided that of the 7.5 million acre-feet annual water apportioned to the Lower Basin, Nevada would be entitled to 300,000 acre-feet annually, Arizona 2.8 million acre-feet annually plus one-half of any eexcess or surplus waters unapportioned by the Compact, and California 4.4 million acre-feet annually plus one-half of any excess or surplus waters unapportioned by the Compact. This apportionment was never agreed upon by the Lower Basin States, but in 1964 the United States Supreme Court in Arizona v. California (373 U.S. 546) concluded that agreement was unnecessary in that the Project Act authorized the Secretary of Interior to deliver the water in accordance with the apportionment.

3. Seven Party Agreement

In order to complete the apportionment between the users in California, the Secretary of Interior requested the State of California to provide a schedule of water rights priorities among the major users. On August 18, 1931, the California Seven Party Agreement was signed. It contained the following priorities: (See next page)

In addition, the people of Colorado, New Mexico, Utah and Wyoming (the Upper Basin States) became increasingly aware of California's expanding use of Colorado River water. The existing law at that time provided that states' water rights were to be determind according to the doctrine of priority of appropriations; that is, the earlier the appropriation, the greater the right. As a result, the Upper Basin States and the Lower Basin States (Arizona, California, and Nevada) entered into an inter-state agreement which equitably divided waters of the Colorado River. This agreement, the Colorado River Compact, provided, among other things, that the Upper Basin States and the Lower Basin States were each entitled to the exclusive beneficial consumptive use of 7.5 million acre-feet each year, in perpetuity.

The Compact provided that the consent of the United States was necessary. The consent of the United States was conditioned by Section 4 (a) of the Boulder Canyon Project Act which required that California pass an act limiting California's annual consumptive use of Colorado River water to 4.4 million acre-feet per year, plus not more then one-half of any excess of surplus waters unapportioned by the Compact. California met this requirement by passing the California Limitation Act on March 4, 1929.

2. Boulder Canyon Project

On December 21, 1928, Congress passed the Boulder Canyon Project act which authorized the construction of Hoover Dam and Power Plant and the All-American Canal to Imperial and Coachella Valleys. The contract provided that lands benefiting from the All-American Canal were to repay the cost in 40 years without interest. Those lands were not charged for water or for its use, storage or delivery.

During the early development of the Imperial Valley, certain individuals and the California Development Company made a series of water appropriations as required by California law. These appropriative rights are based upon a series of notices of appropriations made between 1895 and 1899. The notices were posted at Hanlon's Heading, the point of diversion on the Colorado River, and were thereafter recorded. Each of these appropriations was for a flow 10,000 cubic feet per second of the water of the River. The individual appropriations were assigned to the California Development Company. These rights are the basis of the District's present perfected rights as discussed below.

As a result of financial difficulty, the Southern Pacific Company obtained all of the assets of the California Development Company. Included in the property sold was "the water rights, franchises, water heading, and appropriated water rights of the Colorado River owned by said California Development Company."

On July 14, 1911, the Imperial Irrigation District was organized and by deed dated June 22, 1916, Southern Pacific Company conveyed to Imperial Irrigation District all of the property of the California Development Company, including all water rights.

1. Water Division: The Colorado River Compact

Within a few years after the Imperial Irrigation District was organized, irrigation had expanded to such an extent that all of the water in the River was completely used except in times of high flows It was soon recognized that without some flood control and storage facilities, a dependable water supply could not be guaranteed.

The MWD Distribution System has approximately 335 service connections to provide deliveries to member agencies. Prior to adding new service connections, environmental studies are reviewed and preliminary design and cost estimates prepared.

Unusually heavy rains during 1982-83 limited the demand for groundwater replenishment, agricultural water and, in some instances, domestic water. Water deliveries totaled 1,226,361 acre-feet, down approximately 18.4 percent from the previous year; 968,100 acre-feet was for domestic or municipal purposes; 146,289 acre-feet for agricultural purposes; 67,923 acre-feet for replenishment of underground basins and 44,049 acre-feet for injection into seawater barriers.

Domestic and municipal water accounted for approximately 79 percent of total sales. Agricultural uses accounted for approximately 12 percent, compared to 13 percent for the previous fiscal year.

During the fiscal year, Colorado River water was blended with State Project water in an average 50/50 ratio at the Weymouth, Skinner, and Dierner plants. Blended water was supplied to a large part of MWD's service area. The blend at these plants varied somewhat throughout the year to accommodate various shutdowns, to maintain total dissolved solids (TDS) levels below 500 milligrams per liter (mg/l), and to assure satisfactory water quality.

## F. WATER RIGHTS

The Imperial Irrigation Distict holds three classes of water rights: Present perfected rights, federal contractual rights and state permit rights. Each of these will be discussed below.

The MWD distribution system begins at the terminus of the Colorado River Aqueduct at the west portal of San Jacinto Tunnel and State Water Project delivery points at Castaic Lake and Devil Canyon Afterbay. The system consists of 775 miles of pipeline, eight reservoirs, five filtration plants, and numerous regulating structures which are strategically situated along the system. These facilities provide water throughout the Southern California coastal area for domestic, municipal, agricultural, and groundwater replenishment purposes.

The MWD has five filtration plants which filter Colorado River and State Project waters in compliance with the California State Department of Health Services' requirements.

The MWD operates two terminal reservoirs, one emergency storage reservoir, and five regulating reservoirs in its distribution system. Terminal reservoirs provide storage for seasonal demand variations, while the regulating reservoirs provide operating flexibility. The locations and capacities of the reservoirs are listed in the following:

| Reservoir | Location | in acre-feet |
|---|---|---|
| Lake Mathews - Terminus of the Colorado River Aqueduct | 10 miles southwest of Riverside | 182,800 |
| Lake Skinner - Terminus of the San Diego Canal | 15 miles southwest of Hemet | 44,000 |
| San Joaquin - Regulatory | Newport Beach | 3,000 |
| Live Oak - Regulatory | La Verne | 2,500 |
| Garvey - Regulatory | Monterey Park | 1,600 |
| Palos Verdes - Regulatory | Rolling Hills | 1,100 |
| Orange County - Regulatory | Brea | 200 |
| Morris - Emergency Storage | 5 miles north of Azusa on the San Gabriel River | 30,000 |

The contracts call for the SWP to provide a firm yield, a supply which is to be available during a repeat of a historic seven-year dry period. From now forward, should a similar dry period occur, present SWP facilities will be incapable of supplying all of the water required by contract and requested by the contractors. The SWP was to be built in stages, as the demand for water increased.

The existing facilities of the SWP now provide about half of the firm yield for which 30 public agencies ultimately contracted. Planning for additional facilities had been under way for several years. However, immediately following failure of Proposition 9, the referendum on Senate Bill 200, DWR suspended planning studies of two reservoirs, the Thomes-Newville in the Sacramento Valley and Los Vaqueros located southwest of the Delta; and a Delta transfer facility. Senate Bill 200 was the State's plan providing for continued development of the State's water resources, while setting forth conditions for specified new projects.

In 1984, efforts by the Governor and Legislature to pass a "water package" failed once more. Proponents of the package were optimistic early in the year because the major elements - a "Through-Delta channel" and storage facilities south of the Delta, seemed to be acceptable to Delta, fishery, and environmental interests, formerly opposed to the "Peripheral Canal" as proposed by SB-346 and SB-200.

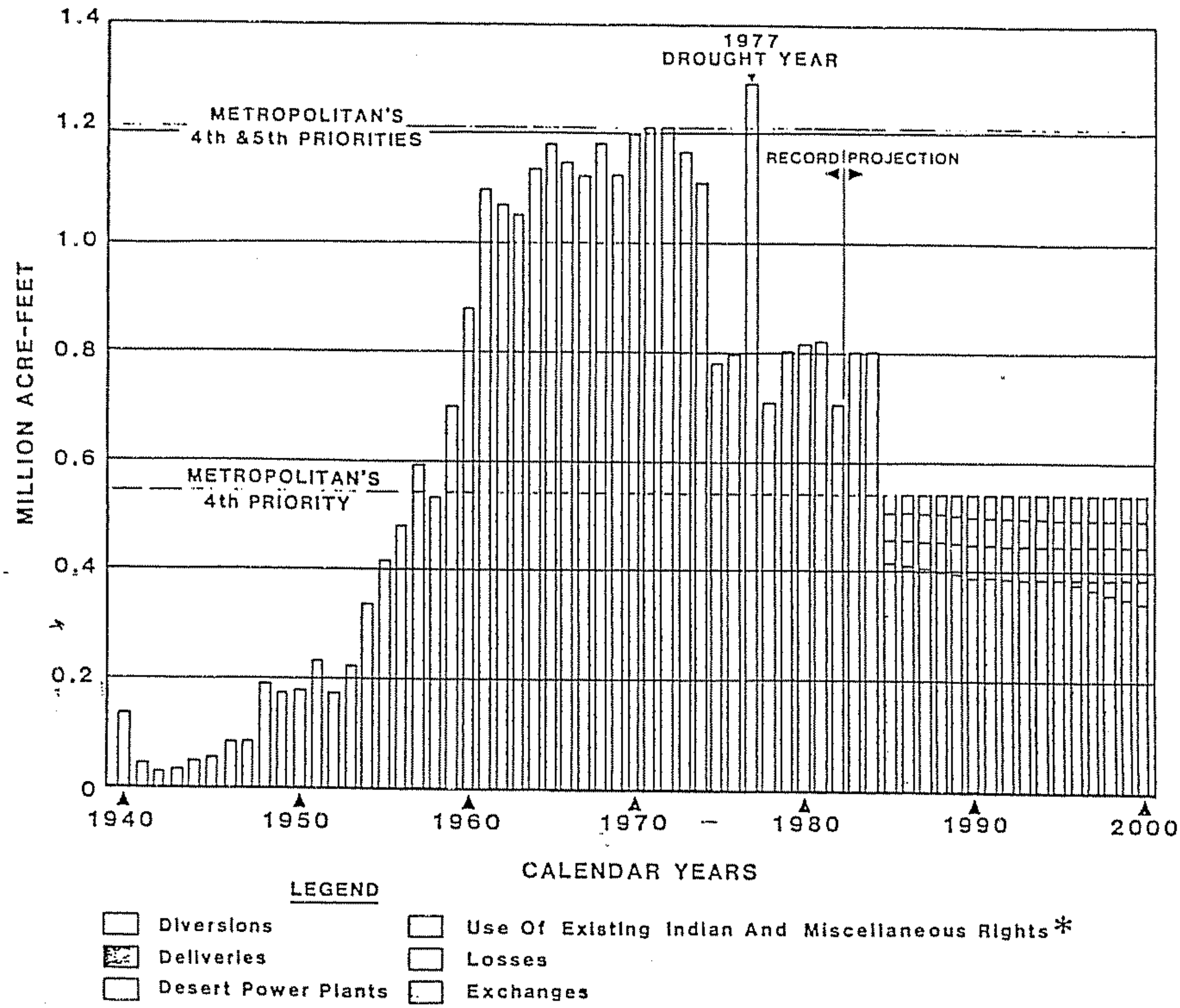
State contractors intend to prepare new legislation for introduction in 1985. Without a Delta transfer facility, the State cannot meet its contractual obligations for delivery of water especially to MWD, the largest contractor, with an ultimate entitlement of 2 MAF, one half of total SWP contracts.

inverted siphons that cross under drainage channels or other topographical depressions; two reservoirs, and transmission lines that deliver power for system pumping plants from Hoover and Parker power plants and from the Southern California Edison Company. The aqueduct was designed for a capacity of 1,605 cfs which would provide for the delivery of the MWD's annual entitlement to Colorado River water if operated at that flow 92 percent of the time. The aqueduct is capable of carrying flows slightly higher than this design capacity.

The five pumping plants lift Colorado River water a total of 1,617 feet to convey it to the MWD service area. Each plant has nine pumps originally designed with a 200 cfs individual pumping capacity. Through various modifications, the individual pumping capacity of each pump has been increased so that the capacities now average 200 cubic cfs. Operation of eight pumps at each plant will deliver the MDW's annual entitlement to Colorado River water. The ninth pump is used as a spare to facilitate maintenance, repairs, and/or to provide additional emergency pumping capacity.

MWD's second source of imported water is the State Water Project operated by the California Department of Water Resources (DWR). Water that is surplus to the needs of the Delta is diverted from natural channels in the southern Delta to supply public agencies with water for which they have contracted. SWP water is conveyed via the Governor Edmund G. Brown California Aqueduct to Castaic Lake on the western side of MWD's service area and to Devil Canyon Afterbay and then Lake Perris on the eastern side of the MWD's service area.

# Metropolitan Water District — Colorado River Water Supply




* A lawsuit now pending could result in additional water rights being granted to the Indian tribes.

Exhibit I.2

Charges are made for several components of costs to cover capital, operating, and maintenance costs. The capital cost and minimum O&M components must be paid regardless of the quantity of water received by a Contractor. Other charges are based on quantities delivered.

5. Metropolitan Water District of Southern California

This agency, serving the major cities and urban areas of the Southern California coastal plain was formed in 1928 for the purpose of building an aqueduct from the Colorado River and distributing water to its member cities. Planning had begun in 1923 under the leadership of William Mulholland. Construction started in 1933, and the aqueduct including 29 tunnels and five pumping plants, began delivering Colorado River water to several of MWD's member cities in June 1941. The MWD historic and projected water supply is shown in Exhibit I.2.

Water for the south coastal area of California served by MWD comes from four sources: Local water supplies, the Los Angeles Aqueduct supply from the Mono Basin-Owens Valley, Colorado River and State Water Project.

The Colorado River Aqueduct beginning at the W. P. Whitsett Intake Pumping Plant on the western shore of Lake Havasu, extends a distance of 242 miles, carrying Colorado River water to Lake Mathews, its terminal reservoir near Riverside, California.

The aqueduct system consists of five pumping plants - Whitsett, Gene, Iron Mountain, Eagle Mountain, and Hinds; 92.1 miles of concrete lined canal 54.5 miles of concrete conduit; 28.5 miles of

The Department of Water Resources estimates the current capability of The project to meet projected water demands as shown in the following tabulation:

| FIRST YEAR PROJECT WATER DEMANDS EXCEED SUPPLIES | | |
|---|---|---|
| | Water Demand | |
| Water Supply [a] | Table A [b] | Contractor Requests |
| Present Min. Project Yield (2.5 MAF) | 1982 | 1985 |
| "Dry" Year (2.47 MAF) | 1982 | 1985 |
| "Average" Year (3.19 MAF) | 1986 | 1990 |
| "Wet" Year (2.49 MAF) | 1987 | 1995 |

[a]Water supply amounts exclude operational water losses.

[b]Control amounts

Source: DWR Bulletin 132-83, December 1983

The 31 Contractors from State Water Project will pay 80 percent of SWP costs, power users 13 percent, and the remaining costs by state and federal funds for flood control, recreation, fish and wildlife benefits.

ponents is 562 miles. The Aqueduct features include several pumping plants and reservoirs.

d. San Luis Dam near Los Banos is a joint federal-state feature, with a capacity of 2.1 MAF.

e. The A. D. Edmonston Pumping Plant south of Bakersfield with total capacity of 2742 cfs, lifts water over the Tehachapi Mountains over 2000 feet - which is more water pumped higher than anywhere else in the world.

The SWP was designed for a delivery capacity of 4.23 MAF, and with contracts to deliver over 4 MAF annually, it presently provides about 2 MAF each year.

No significant features have been added to increase the yield of the project since 1973. Efforts by the Legislature in the past few years have failed to win approval of necessary Delta facilities. The proposed Peripheral Canal would have increased the dry weather yield of the SWP by an estimated 700,000 acre-feet, now wasted to the ocean and helping to preserve fishing and water quality in the Delta. Efforts by the Legislature in 1984 to authorize Delta transfer facilities failed once again.

The Department of Water Resources (DWR) is currently projecting a 10 percent increase in statewide net water use from 33.8 MAF in 1980 to 37.3 MAF per year by 2010.

4. State Water Project

In 1951, the Legislature authorized the State Water Project. In 1957, the Water Resources Plan, conceived as a general guide to water development projects and management strategies, was completed.

Together with the CVP, the State Water Project (SWP) was planned to conserve surplus water from sources in Northern California and move it south to meet expanding agriculture and urban water needs in Central and Southern California.

The Burns-Porter Act, passed in 1959 provided the major financing for the initial features of the SWP (known earlier as the Feather River Project), and in 1960, the voters approved a $1.75 billion bond issue to finance the original features, and construction began.

The initial features of the Project, completed in 1973 included 18 reservoirs, 15 pumping plants, and 540 miles of aqueducts. In addition to storage and distribution, the SWP provides recreational opportunities and enhances fish and wildlife.

The major features of the SWP are:

a. Oroville Dam on the Feather River, with 3.5 MAF storage capacity is the Project's principal reservoir;

b. The Delta Pumping Plant lifts water 244 feet into the California Aqueduct.

c. The California Aqueduct extends 444 miles from the Delta to Perris Reservoir. The aggregate length of its several comto the San Joaquin Valley is lifted about 200 feet into the Delta Mendota Canal which terminates 120 miles southerly at Mendota pool on the San Joaquin River with some releases between, but mainly supplying a replacement source to lands formerly irrigated by San Joaquin River flows. During the winter, the Canal brings surplus water from the Delta to San Luis Reservoir, a joint federal-state facility near Los Banos, serving the west side of the San Joaquin Valley (Westlands Water District and others).

The Friant-Kern Project, consisting of Friant Dam on the San Joaquin River near Fresno and its two canals, the 360-mile long Madera Canal, and the 160-mile Friant-Kern Canal extending south to Kern County, is the major unit serving the east side of the San Joaquin Valley from Chowchilla south to Bakersfield. The joint federal-state San Luis Canal extends 102 miles to Kettleman City, where it continues southward as the California Aqueduct.

Numerous other dams and reservoirs, hydro plants, pumping plants, and several large canals make up the complex system which provides supplemental water to about 4 million acres of agricultural land in California's Central Valley. In 1980, total project deliveries were about 7 MAF for all uses.

After some 43 years of operations, the CVP is not yet complete. New Melones Dam on the Stanislaus River, completed in 1978, has been prevented from full use by litigation; Auburn Dam on the North Fork of the American River, upon which construction started in 1974, is at a standstill and wrapped in controversy; and the Kellog Unit to serve San Benito and Santa Clara Counties is under construction and expected to be completed soon.

The East Bay Municipal Utility District (EBMUD) formed in 1923, decided to develop its main water supply on the Mukelumne River, and completed construction of Pardee Dam and a 130-mile long aqueduct to serve the cities and towns along the edge of San Francisco Bay from Rodeo (north of Richmond) to San Lorenzo (north of Hayward). The current average annual import is about 300,000 acre-feet per year.

3. Central Valley Project

In 1933, the Legislature passed the State Central Valley Act, after California had suffered through a long drought that began in 1928. Due to the depression of the 1930's, the state could not finance the project and asked the federal government for help. The federal CVP accomplished much of the water development which the 1933 State Act authorized.

Development of the Central Valley Project (CVP) began in 1935 by the U. S. Bureau of Reclamation (USBR), after years of study and planning by the State of California. This project serves the Sacramento and San Joaquin valleys and consists of a major network of dams, reservoirs, hydroelectric plants, and canals primarily furnishing irrigation water to the rich Central Valley of California. The key feature of the CVP is Shasta Dam, completed shortly after World War II. Its water storage capacity is 4.5 MAF, and its 375 MW hydroelectric power plant produces 1.2 billion kwh.

The CVP was designed and built to impound headwaters of the Sacramento and Trinity Rivers, and to release water as needed down the Sacramento River, through the Delta, where some 22 rivers and streams converge. At a pumping plant near Tracy, water for delivery began flowing south from the eastern High Sierra to the San Fernando Valley. Hydroelectric plants were later constructed along the aqueduct, which had an initial capacity of 200 mgd. In 1940, the system was extended northward to the Mono Basin. Later, a second barrel was added to the aqueduct between Owens and San Fernando Valleys.

The Los Angeles Aqueduct today is the city's main source, importing about 500,000 acre-feet per year. The city was instrumental in formation of MWD, for the purpose of developing a supply from the Colorado River. Today, although the amount varies from year to year, the city only receives between 21 and 46 thousand acre-feet per year from MWD.

2. San Francisco - East Bay Area

Since San Francisco has practically no local water supply, it has been necessary to import water to the city from the beginning. Other than water being hauled in on barges from Saucelito, the first imported water for San Francisco was received through a system of flumes and tunnels from Lobos Creek. Later, water projects were developed on the east side of San Jose to store local runoff.

After lengthy studies and struggles with naturalist interests opposing the development, the city constructed the primary phase of the Hetch Hetchy project on the Tuolumne River within the limits of Yosemite National Park, and placed it in service in 1934. Today the 134-mile long aqueduct lines convey about one-half MAF per year to the city.

With the gold rush of 1849, more complex water systems were developed, consisting of small reservoirs and open ditches. Some of those original systems are still in use today.

As gold mining declined, agriculture became increasingly important. Water companies and irrigation districts were formed (following passage of the Wright Irrigation District Act in 1887) and before the turn of the century, irrigated agriculture was expanding rapidly in the central and Southern California coastal areas, and the Sacramento and San Joaquin valleys, usually along or close to natural streams. During the 1880's, the first several dams were constructed including Bear Valley, Hemet, Sweetwater, and Cuyamaca. Shallow wells were dug, many reaching artesian (flowing) water, but not until about 1910 with the advent of deep well turbine pumps did groundwater become important as a water source.

As the cities of Los Angeles and San Francisco began to outstrip their local supplies soon after 1900, it became apparent that imports of water from other areas would be necessary. Other projects followed which are described briefly below. All had one purpose in common - to move water from at or near its source to the place of need. In nearly all cases, storage facilities near the source was required.

1. Los Angeles

   As early as 1900 it became apparent that local water supplies would not be sufficient to satisfy the rapidly growing city of Los Angeles, and studies were begun by William Mulholland to find a new water source. Although it was more than 200 miles away, Mulholland's surveys determined that water could be brought from Owens Valley to Los Angeles by gravity. Bonds were sold, reservoirs, canals, tunnels, and pipelines built, and in 1913, water

In addition to in-state streams, there is inflow from Oregon through the Klamath River to Northern California and from the Colorado River into Southern California.

The total annual surface water supply in the state, including the Klamath and Colorado developed by man-made dams, reservoirs, other diversion works, and distribution systems, averages about 23 MAF. An additonal 16 MAF is pumped from groundwater. In some areas, groundwater pumping exceeds the average annual recharge, causing watertables to decline. When Colorado imports (4.4 MAF) and reclaimed waste water (0.7 MAF) are included, the total developed water supply in the state is about 44 MAF.

California's aggregate annual demand for water today is about 42 MAF, almost 36 MAF for agriculture and 5.8 MAF for urban use in an average year. State Bulletin 160-83 reports that net water use in 1980 was 33.8 MAF and projected net use in 2010 will be 37.3 MAF, considerably lower than projections made 20 years before. To meet that demand, it is apparent that additional water supplies in the aggregate amount of about 3.5 MAF needs to be made available by development, reclamation, reuse - or the demand must be reduced by water conservation or other means. In years past, California met water demands by constructing diversion and storage works and conveyance systems. During the last two decades the main efforts have been on reclamation and conservation.

Water development and use started in California with Spanish missions in the late 1700's, where gardens of fruits, vegetables and occasional grain fields were irrigated by diversions from local streams.

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*U. C. Extension Leaflet 21379, 1984

In reference to the proposal for MWD to fund water savings improvements in Imperial Valley, the Governor stated that:

> "This program has statewide significance because any water which MWD can obtain by water salvage directly reduces its need to import water from Northern California."

Although population in California continues in increase, no new major water projects have been constructed during the past decade or so. The focus instead has been on <u>conservation</u> - in the sense of using less water, and reclamation (treatment and reuse of sewage effluent).

California is a state of vast contrasts in climate, ranging from subtropical to alpine; and geography from desert to seashore, to 14,000 foot high mountains. Precipitation ranges from 2" to 100" and more per year. Furthermore, precipitation and runoff are highly variable from year to year, ranging from wet to dry, with below normal precipitation often occurring several years in a row. During the year, all of the snow and most of the rain falls during a few winter months, while the greatest demands for water occur in the summer after the snow in the mountains has melted and run off.

Total rain and snow falling within California averages over 190 million acre feet (MAF) per year. But, less than half that amount - about 74 MAF* - flows into streams and rivers and becomes available for uses such as drinking water, irrigation, fish and groundwater recharge.

More than one-half of the total annual runoff flows into the Pacific Ocean, often in the form of the flood flows, but many streams such as those on the North Coast flow unchecked year-round into the ocean.

The importation of Colorado River water into Imperial Valley was among the earliest water projects constructed in the state. Although physically separated from the major projects - Central Valley Project (CVP) and State Water Project (SWP) - Imperial Valley has become a part of the whole state water picture. Since several other California entities, especially Metropolitan Water District (MWD), also divert water from the Colorado River, transfer and exchange of water are physically possible, it is important to understand the major elements of California's vast water system.

Development of each project was started to fulfill a need, sometimes due to droughts or floods, but usually to furnish a water supply for urban growth, agricultural expansion or hydroelectric power. The reservoirs constructed for most of these projects are multi-purpose, providing recreation and aesthetic benefits as well as flood control and the other primary uses. These reservoirs provide <u>conservation</u> - in the sense of storing surplus water (usually during the spring), and releasing it later (usually during the summer) for beneficial uses. Governor Deukmejian recently stated to the California Legislature that:

> "Water is the lifeblood of California. In a semi-arid region, with incomparable climate and rich soils, it is our most precious resource.
>
> Over more than 100 years, the people of the state have built a vast interrelated system of dams, reservoirs, canals and hydroelectric plants. Every city and town, every farm, every factory has benefited. In many ways, our prosperity as a state has paralleled our development of water resources."

mation must be presented in understandable and usable form to the water user and even to the general public. This will be a continuing effort, whereas, the physical or structural elements of water conservation can be accomplished more rapidly, dependent mainly upon the availability of funds.

Finally, a serious water conservation effort will assure Imperial Valley of a firm and sufficient water supply to fully meet our requirements.

During the past years, the Bureau of Reclamation has been studying water conservation "Opportunities" in Imperial Valley. Their studies have proposed that there are opportunities to save water by structural and nonstructural improvements and programs, not unlike the District's existing programs.

The Imperial Irrigation District record in water conservation has been gradual and progressive during the past three decades.

Currently, great emphasis is being put on funding of water conservation improvements in exchange for the quantity of water saved by agencies outside Imperial Valley. Specifically, the Metropolitan Water District of Southern California, the Parsons Engineering Company and others recognize that urban users can afford to pay a higher price than agricultural water users in Imperial Valley, whether it be for new water projects, reclamation, or water conservation.

## E. STATEWIDE WATER PERSPECTIVE

Water resources projects in California have been developed over the last century in response to increasing demands resulting from population growth and expansion of irrigated agriculture, and today this state has the most complex and extensive water system in the world.

TABLE I.1

DELIVERY EFFICIENCIES OF IRRIGATION DISTRICTS

| Irrigation Districts | 1975 | 1976 | 1977 | 1978 |
|---|---|---|---|---|
| Imperial Irrig. Dist. | | | | |
| onfarm efficiency | 73 | 80 | 81 | 77 |
| district efficiency | 65 | 71 | 73 | 70 |
| Coachella Valley I.D. | | | | |
| onfarm efficiency | 51 | 50 | 55 | 53 |
| district efficiency | 43 | 44 | 46 | 46 |
| Reservation Div. I.D. | | | | |
| onfarm efficiency | 45 | 47 | 58 | 60 |
| district efficiency | 36 | 38 | 47 | 50 |
| Y.C.W.U.A. (Valley Div.)I.D. | | | | |
| onfarm efficiency | 64 | 80 | 71 | 72 |
| district efficiency | 49 | 60 | 54 | 52 |
| Yuma Mesa Irr.&D.D. | | | | |
| onfarm efficiency | 33 | 33 | 29 | 32 |
| district efficiency | 30 | 30 | 27 | 30 |
| Unit "B" Irrig. Dist. | | | | |
| onfarm efficiency | 33 | 32 | 35 | 38 |
| district efficiency | 32 | 31 | 33 | 36 |
| Yuma Irrigation Dist. | | | | |
| onfarm efficiency | 62 | 63 | 61 | 61 |
| district efficiency | 59 | 61 | 59 | 53 |
| North Gila Irrig. Dist. | | | | |
| onfarm efficiency | 29 | 40 | 46 | 42 |
| district efficiency | 28 | 30 | 43 | 40 |
| Wellton-Mohawk Irrig. Dist. | | | | |
| onfarm efficiency | 55 | 52 | 63 | 64 |
| district efficiency | 50 | 47 | 57 | 57 |
| Colorado Riv. Indian Tribes | | | | |
| onfarm efficiency | 57 | 65 | 76 | 64 |
| district efficiency | 44 | 50 | 58 | 48 |
| Palo Verde Irrig. Dist. | | | | |
| onfarm efficiency | 46 | 33 | 45 | 42 |
| district efficiency | 36 | 26 | 35 | 33 |

Irrigation practices in California have already reached a high level of proficiency. Imperial Irrigation District has been recognized by the USBR as having one of the highest overall water use efficiencies in the lower Colorado River area. (See Table I.1.)

Imperial Irrigation District's efficiencies are comparable to irrigated agriculture in the entire west. Furthermore, water use efficiency by agriculture is much higher than that by urban use, where large proportions of water flow through sewage treatment plants and, in the case of coastal cities, discharge into the Pacific Ocean.

Salvage of water can be accomplished in the District irrigation system by physical means, such as lining canals, automated controls, reservoirs, and other recovery systems.

The water users can also make physical improvements. and practice better water management procedures. Together, the District and its water users must work together to make the best use of water consistent with practical and economic limitations.

The water user can benefit significantly by irrigation management. It is highly probable that he will be able to order and use less water, and conceivably increase yields.

As the District improves its system toward a goal of computerized management and automated system control, it is probable that significant reductions in operating and maintenance costs can be realized.

Any water conservation plan, to be effective must have the support of all water users. Considerable education will be necessary, requiring the cooperation of local, state, and federal expertise. Applicable infor-

The following are a few examples of agricultural water conservation methods. 1/

1. Storing water in surface impoundments allowing for timely releases;

2. Storing water underground where it is not subject to evaporation or outflow to the ocean;

3. Lining delivery and distribution canals and ditches to reduce seepage losses;

4. Improving irrigation efficiency by reducing tailwater runoff and deep percolation through improved water application systems and timing of irrigations;

5. On-farm and basin return flow systems, recycling water a number of times within the farm or basin can result in high farm and basin efficiencies;

6. Reducing irrecoverable flows to the ocean or salt sinks by diverting or intercepting them for beneficial purposes before they are lost;

7. Use of brackish water through special management, salt-tolerant crops or for biomass production;

8. Through genetics, develop shorter season crops, or varieties that use less water and tolerate drought with economical production;

9. Reducing irrecoverable evapotranspiration losses to the air by modifying water surfaces, watershed and riparian vegetation by crop selection, and by more carefully managing irrigation.

1/ David C. Davenport and Robert M. Hagen, 1979. Assessing Potentials for Agricultural Water Conservation, Pages 6-11. Western Water, November/December 1979, issue published by Western Water Foundation.

exceed the net dependable supply by about 3 MAF per year. The question also arises: Do we have the technical ability to accomplish a 10% agricultural water savings in the near future?

> "The subject of agricultural water conservation and increased agricultural efficiency has been receiving more public attention during the last year. In May, the State Department of Water Resources convened a pannel of out-of-state experts to advise on water conservation programs and potentials in California. The panel concluded that a potential exists for saving water, although they recognized that irrigation practices in many areas of California are already highly efficient. The panel concluded, 'Statewide implementation of water conservation measures will help reduce the water shortages forecast for the near future, without curtailing the present level of agricultural production or economic activity.'"

In a recent issue of Western Water (November-December, 1984) editor Sudman writes as follows:

> "While agricultural water experts and economists argue about conservation figures, the public sometimes gets lost in a maze of statistics. Farm conservation practices may seem irrelevant to those of us who live in urban areas. But the basic reason why this subject concerns the non-farmer is that water saved through efficient agricultural practices could, theoretically, free water for urban use."

The other articles in the issue verry well describe the issue of possible agricultural water savings through conservation.

There has been statewide emphasis placed on urban water use efficiency, as well as reclamation of sewage effluent for beneficial uses. Agricultural water conservation is aimed at reducing losses which occur in the storage and distribution of water for the end purpose of consumptive use by crops. Gross water use by agriculture would equal consumptive use plus, in the case of Imperial Valley, leaching requirements, divided by overall efficiency of distribution and application. Increasing this efficiency factor is the primary goal of water conservation.

The term conservation means different things to different people. Webster's New World Dictionary defines conservation as:

> "(1) the act or practice of conserving; protection from loss, waste, etc.; preservation; (2) the official care and protection of natural resources."

Agricultural water conservation is being emphasized in the state because of the magnitude of water use. This is pointed out in an article by Rita Sudman in a recent issue of Western Water which in part states:

> "Californians often see the much-quoted statistic that agriculture uses 85% of the delivered water in the state. Therefore, when we are asked to conserve water, those aware of this statistic often raise questions about the importance of saving water in our homes and offices when agriculture uses so much. Environmental groups have taken up this cry in the form of the "10% solution." They reason that if agriculture saved between 10-20% a year of the 36 million acre-feet (MAF) of delivered water, there would be no need to develop additional water resources. However, the state presently estimates that by the year 2000, California's net water demand may

California still has untapped water resources and developing these water supplies will be necessary. We must, however, try to use our existing water supplies more efficiently, since this is often cheaper and less demanding to the environment than developing new supplies. Water conservation has thus become a national and state priority.

Water is becoming increasingly expensive, and political and social problems of developing new supplies have become more and more difficult in the last two decades or so. Conservation, or using water more efficiently, can be cheaper and possibly less demanding on the environment than developing new supplies. Although it is generally recognized that water supply projects will still be needed to increase the developed supply from the available resources in the state, water conservation must be emphasized.

Imperial Irrigation District has a firm, relatively large water supply. Due to impending water shortages in the Southern California metropolitan area and the obvious limitations of the Colorado River as a resource, the District is looked on jealously and critically. Discharge of drainage water into the Salton Sea is considered by critics to be wasteful. Some critics do not understand nor accept the need for leaching to maintain our agricultural economy. Furthermore, agricultural drainage from Imperial Valley provides fresh water replenishment to the Salton Sea making it a valuable recreation, fishery and wildlife area enjoyed by thousands of visitors. However, the level of the Salton Sea has risen gradually and continually for many years as the result of the inflow from Mexico, natural (storms) and man-made sources exceeding evaporation. It is possible that reduction in agricultural drainage could help stabilize the level of the Sea. Putting all these factors in perspective, water conservation is necessary to provide the highest water use efficiency related to all beneficial uses.

Section 22078 provides, "A district may control, distribute, spread, sink, treat, purify, recapture and salvage any water including but not limited to sewage waters for the beneficial use or uses of the district or its inhabitants or the owners of rights to waters therein."

Section 21385 states, "The board except as otherwise specifically provided has the power and it shall be its duty to manage and conduct the business and affairs of the district."

Section 22842 describes certain specific powers of the board; and provides that the Board may:

(a ) Provide for and create divisions or departments for management and operating purposes.
(b) Appoint department heads.
(c) Classify and reclassify employees.
(d) Fix the duties, terms, and time of employment.
(e) Provide for and fix salaries, compensation, and expenses of department heads, executives, and employees.

The Board of Directors has adopted Rules and Regulations governing the distribution and use of water and construction, operation and maintenance of the canal and drainage system of the District. A copy of the current regulations are included in the Appendix to this Plan.

## D. NEED FOR CONSERVATION

As the population of California and the western sun belt states increases, and as the demand for the food and fiber products produced by western irrigated agriculture increases, the problem of providing water to meet these demands becomes more difficult.

Management is under the direction of the General Manager, with five departments, each headed by a Department Manager. These departments are:

Water
Power
Operations Services
Personnel
Finance and Accounting

power are functions of the Power Department. Separate accounting records are maintained for each of the two departments.

The Executive Office staff serving the Board consists of the Executive Officer and the Secretary to the Board.

In accordance with California Water Code:

> Section 22075 states, "A district may do any act necessary to furnish sufficient water in the district for any beneficial use".

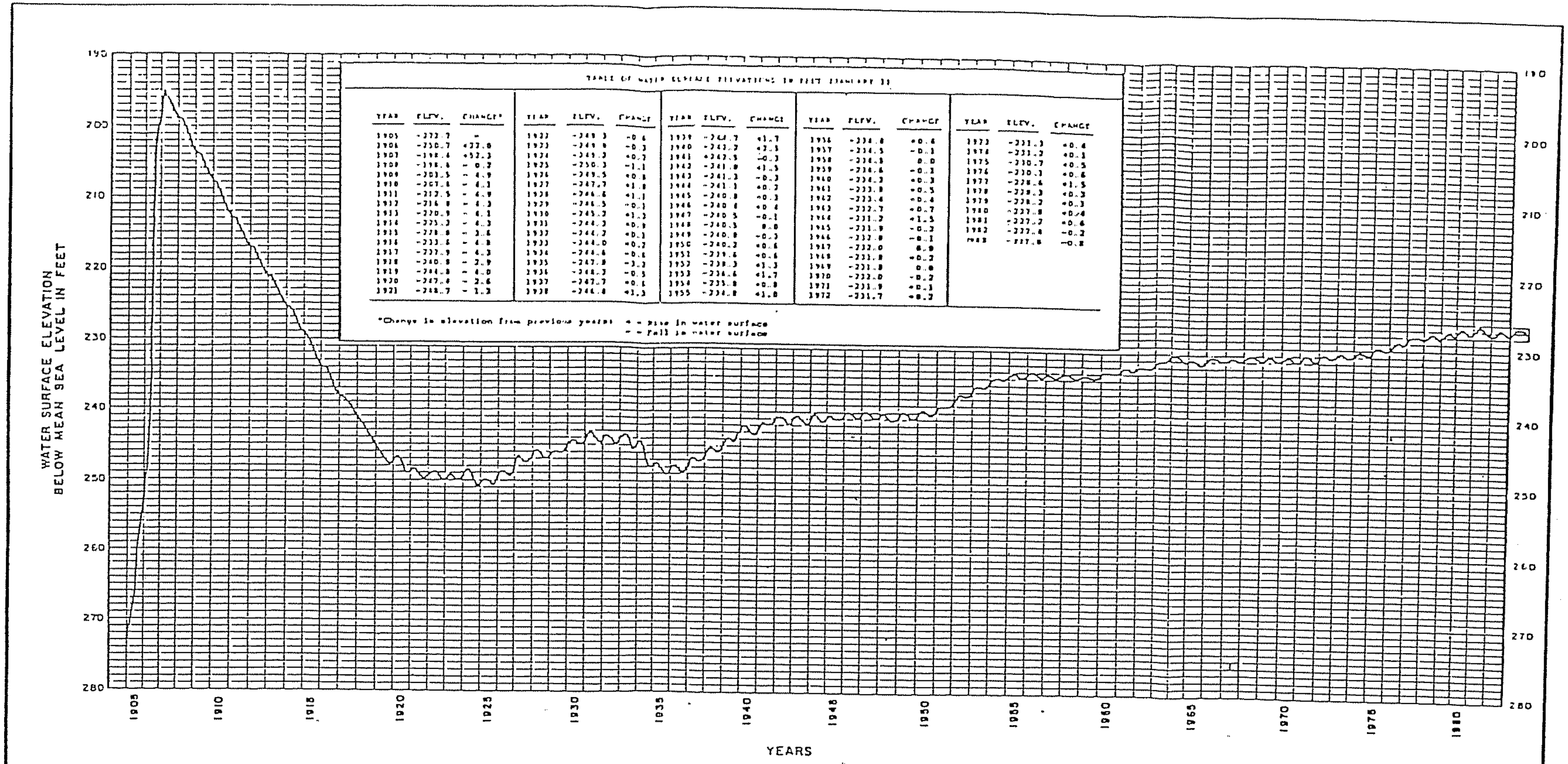



TABLE OF WATER SURFACE ELEVATIONS IN FEET (JANUARY 1)

| YEAR | ELEV. | CHANGE* | YEAR | ELEV. | CHANGE | YEAR | ELEV. | CHANGE | YEAR | ELEV. | CHANGE | YEAR | ELEV. | CHANGE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1905 | -272.7 | - | 1922 | -249.3 | -0.6 | 1939 | -244.7 | +1.7 | 1956 | -234.4 | +0.4 | 1973 | -231.3 | +0.4 |
| 1906 | -250.7 | +22.0 | 1923 | -249.6 | -0.3 | 1940 | -243.2 | +1.5 | 1957 | -234.5 | -0.1 | 1974 | -231.2 | +0.1 |
| 1907 | -198.4 | +52.3 | 1924 | -249.3 | +0.3 | 1941 | -243.5 | -0.3 | 1958 | -234.5 | 0.0 | 1975 | -230.7 | +0.5 |
| 1908 | -198.6 | - 0.2 | 1925 | -250.3 | -1.1 | 1942 | -241.8 | +1.5 | 1959 | -234.6 | -0.1 | 1976 | -230.1 | +0.6 |
| 1909 | -203.5 | - 4.9 | 1926 | -249.5 | +0.8 | 1943 | -241.3 | -0.3 | 1960 | -234.3 | +0.3 | 1977 | -228.6 | +1.5 |
| 1910 | -207.8 | - 4.3 | 1927 | -247.7 | +1.8 | 1944 | -241.1 | +0.2 | 1961 | -233.8 | +0.5 | 1978 | -228.3 | +0.3 |
| 1911 | -212.5 | - 4.7 | 1928 | -246.6 | +1.1 | 1945 | -240.8 | +0.3 | 1962 | -233.4 | +0.4 | 1979 | -228.0 | +0.3 |
| 1912 | -216.8 | - 4.3 | 1929 | -246.5 | +0.1 | 1946 | -240.4 | +0.4 | 1963 | -232.7 | +0.7 | 1980 | -227.8 | +0.4 |
| 1913 | -220.9 | - 4.1 | 1930 | -245.2 | +1.3 | 1947 | -240.5 | -0.1 | 1964 | -231.2 | +1.5 | 1981 | -227.2 | +0.6 |
| 1914 | -225.2 | - 4.3 | 1931 | -244.3 | +0.9 | 1948 | -240.5 | 0.0 | 1965 | -231.9 | -0.7 | 1982 | -227.4 | -0.2 |
| 1915 | -228.8 | - 3.6 | 1932 | -244.2 | +0.1 | 1949 | -240.8 | -0.3 | 1966 | -232.0 | -0.1 | 1983 | -227.8 | -0.8 |
| 1916 | -233.6 | - 4.8 | 1933 | -244.0 | +0.2 | 1950 | -240.2 | +0.6 | 1967 | -232.0 | 0.0 | | | |
| 1917 | -237.9 | - 4.3 | 1934 | -244.6 | -0.6 | 1951 | -239.6 | +0.6 | 1968 | -231.8 | +0.2 | | | |
| 1918 | -240.8 | - 2.9 | 1935 | -247.8 | -3.2 | 1952 | -238.3 | +1.3 | 1969 | -231.8 | 0.0 | | | |
| 1919 | -244.8 | - 4.0 | 1936 | -248.3 | -0.5 | 1953 | -236.6 | +1.7 | 1970 | -232.0 | -0.2 | | | |
| 1920 | -247.4 | - 2.6 | 1937 | -247.7 | +0.6 | 1954 | -235.8 | +0.8 | 1971 | -231.9 | +0.1 | | | |
| 1921 | -248.7 | - 1.3 | 1938 | -246.4 | +1.3 | 1955 | -234.8 | +1.0 | 1972 | -231.7 | +0.2 | | | |

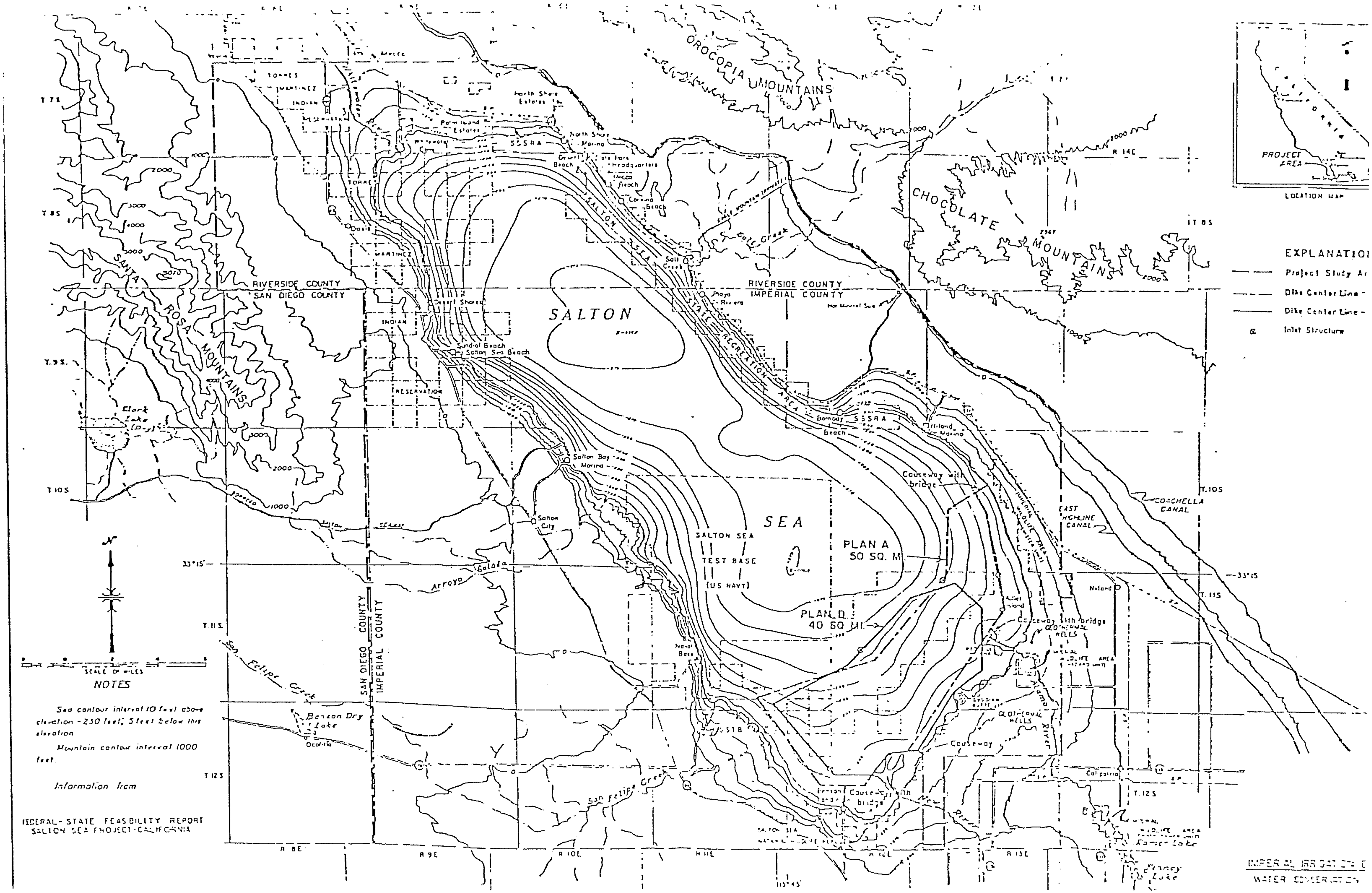
*Change in elevation from previous year: + = Rise in water surface
- = Fall in water surface

SOURCE: IMPERIAL IRRIGATION DISTRICT

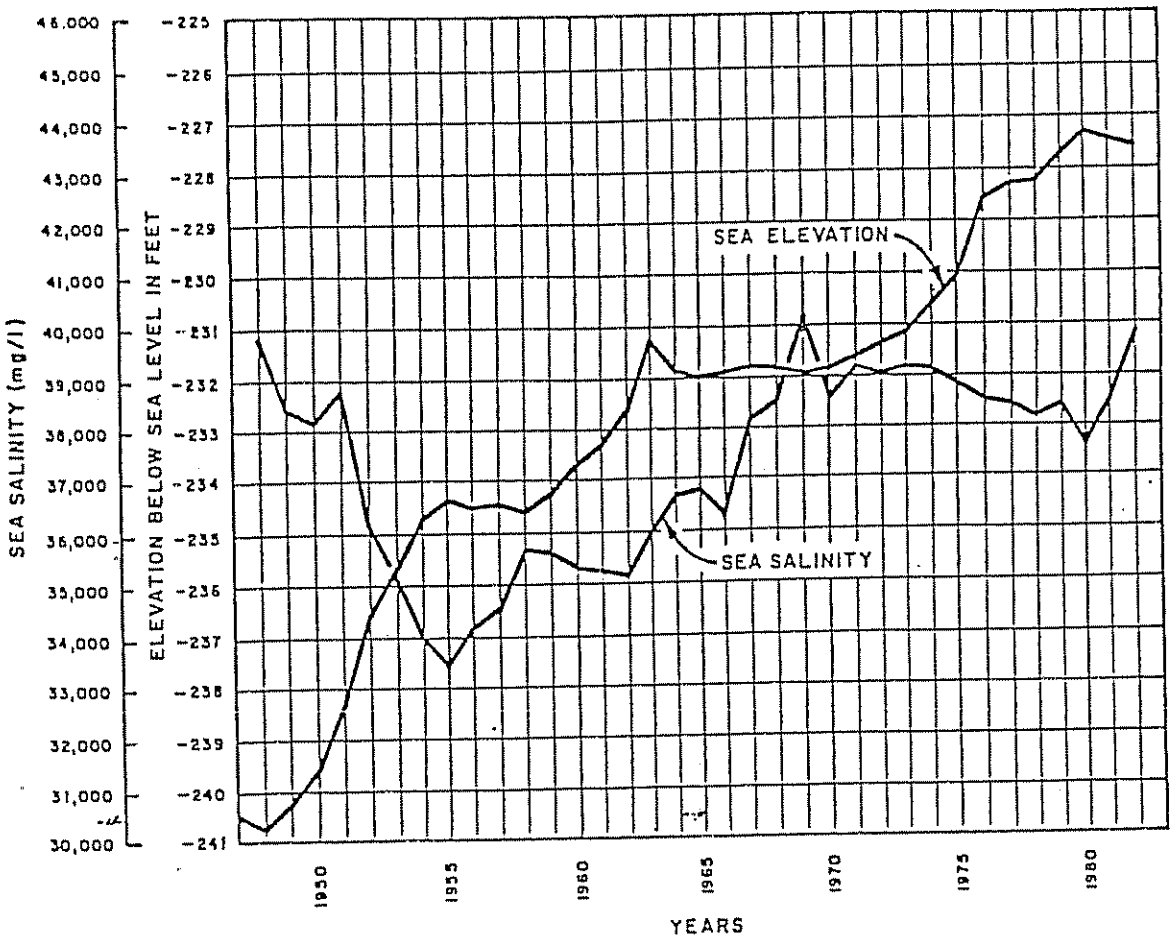
SALTON SEA
HISTORICAL WATER SURFACE ELEVATIONS

BOOKMAN-EDMONSTON ENGINEERING, INC.

SEPTEMBER 1983



OROCOPIA MOUNTAINS
CHOCOLATE MOUNTAINS
SANTA ROSA MOUNTAINS
SALTON SEA
SALTON SEA STATE RECREATION AREA
RIVERSIDE COUNTY
SAN DIEGO COUNTY
IMPERIAL COUNTY
North Shore Estates
Palm Island Estates
North Shore Marina
SSSRA
Headquarters
Salt Creek
Playa Riviera
Desert Shores
Sundial Beach
Salton Sea Beach
Salton Bay Marina
Salton City
Bombay Beach
Niland Marina
Niland
Causeway with bridge
SALTON SEA TEST BASE (US NAVY)
PLAN A 50 SQ. MI.
PLAN D 40 SQ MI.
Naval Base
STB
Causeway
GEOTHERMAL WELLS
WILDLIFE AREA
Alamo River
New River
EAST HIGHLINE CANAL
COACHELLA CANAL
Calipatria
Arroyo Salada
San Felipe Creek
Benson Dry Lake
Ocotillo
Clark Lake (Dry)
Oasis
TORRES
MARTINEZ
INDIAN
RESERVATION
Mecca
T 7 S
T 8 S
T 9 S
T 10 S
T 11 S
T 12 S
R 8 E
R 9 E
R 10 E
R 11 E
R 13 E
R 14 E
33°15'
115°45'
1000
2000
3000
4000
LOCATION MAP
PROJECT AREA
EXPLANATIO
Project Study Ar
Dike Center Line -
Dike Center Line -
Inlet Structure
SCALE OF MILES
NOTES
Sea contour interval 10 feet above elevation -230 feet; 5 feet below this elevation
Mountain contour interval 1000 feet.
Information from
FEDERAL - STATE FEASIBILITY REPORT SALTON SEA PROJECT - CALIFORNIA
IMPERIAL IRRIGATION D
WATER CONSERVATION




NOTES

1. END OF YEAR ELEVATIONS NEAR FIG TREE JOHN.(I.I.D. DATA)

2. AVERAGE OF SAMPLES AT FOUR OR FIVE STATIONS TAKEN IN MAY AND NOVEMBER BY I.I.D.(1982 ANNUAL REPORT, PAGE 32)

HISTORICAL CHANGE IN SALTON SEA'S SALINITY AND ELEVATION

BOOKMAN-EDMONSTON ENGINEERING, INC.

NOVEMBER 1983

Exhibit II.8

and estimates, the USGS Report concluded that the Sea would stabilize at an average elevation of 228 feet below msl, but during the occurrence of a very wet period, the level could rise to 225 feet below msl. As a result, President Coolidge extended the withdrawal of public lands to 220 feet below msl.

Additional studies by state and federal agencies, and by private consultants, have been made during the past 30 years, most of them substantiating that the Sea would stabilize at elevations in the range of 230 to 220 feet below msl.

The District has acquired fee title to, or flooding rights on the majority of private lands in and around the Salton Sea lower than the 230 feet below msl contour line.

In the early 1950's, a keen interest occurred to develop privately owned land around the Sea for recreation and home sites. Imperial County adopted an ordinance requiring developers to make public dedications for lands lower than 220 feet msl. Nevertheless, considerable development has taken place and those properties lower than 226 feet below msl or so have been inundated. Several lawsuits against the District and Coachella Valley Water District (CVWD) have been filed and tried. Except in a few cases, all suits are still in court.

During the past several years the elevation of the Salton Sea has become a sort of barometer, rising in the spring and falling in the summer and fall, usually ending each winter at an elevation higher than the previous year. Due to the fact that agricultural drainage from Imperial Valley is the largest element of inflow to the Sea, those concerned about the rising level of Salton Sea suggest that Imperial Irrigation District should reduce its agricultural drainage in order to stabilize or lower the level of the Sea.

As a matter of fact, inflow to the Sea from Imperial Valley has been reduced during the past several years. The records indicate for example that the inflow from Imperial Valley during the past five years (1979 - 1983) averaged 906,000 acre-feet per year compared to the 23-year average for the years 1961 - 1983 of 950,000 acre-feet per year, a reduction of 44,000 acre-feet per year.

The engineering firm of Bookman-Edmonston has analyzed the records of inflow to the Salton Sea for the period 1976 through 1983. In an affidavit1/ dated July 19, 1984, James L. Welsh of that firm described

his analyses to compare normalized weather and other conditions, using a base period of 1960 - 1983, to actual conditions during 1976 - 1983, a period of abnormal rainfall and other weather conditions. Mr. Welsh states in his affidavit:

> "From 1976 to 1983, precipitation on the Sea averaged 4.83 inches, reaching a high of 8.10 inches in 1983. The inflow from Mexico increased to 245,000 acre-feet in 1983 from an average of 125,000 acre-feet. The increase is largely due to excess flow in the Colorado River reaching Mexico.
>
> "If normalized conditions had existed during 1983, the Sea would have declined nearly half a foot. Thus, in 1983 the excess inflow caused an increase in Sea elevation of about 1.5 feet.

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1/Submitted to SWRCB as a portion of the Appendix to Petition for Reconsideration of Decision 1600, dated July 19, 1984.

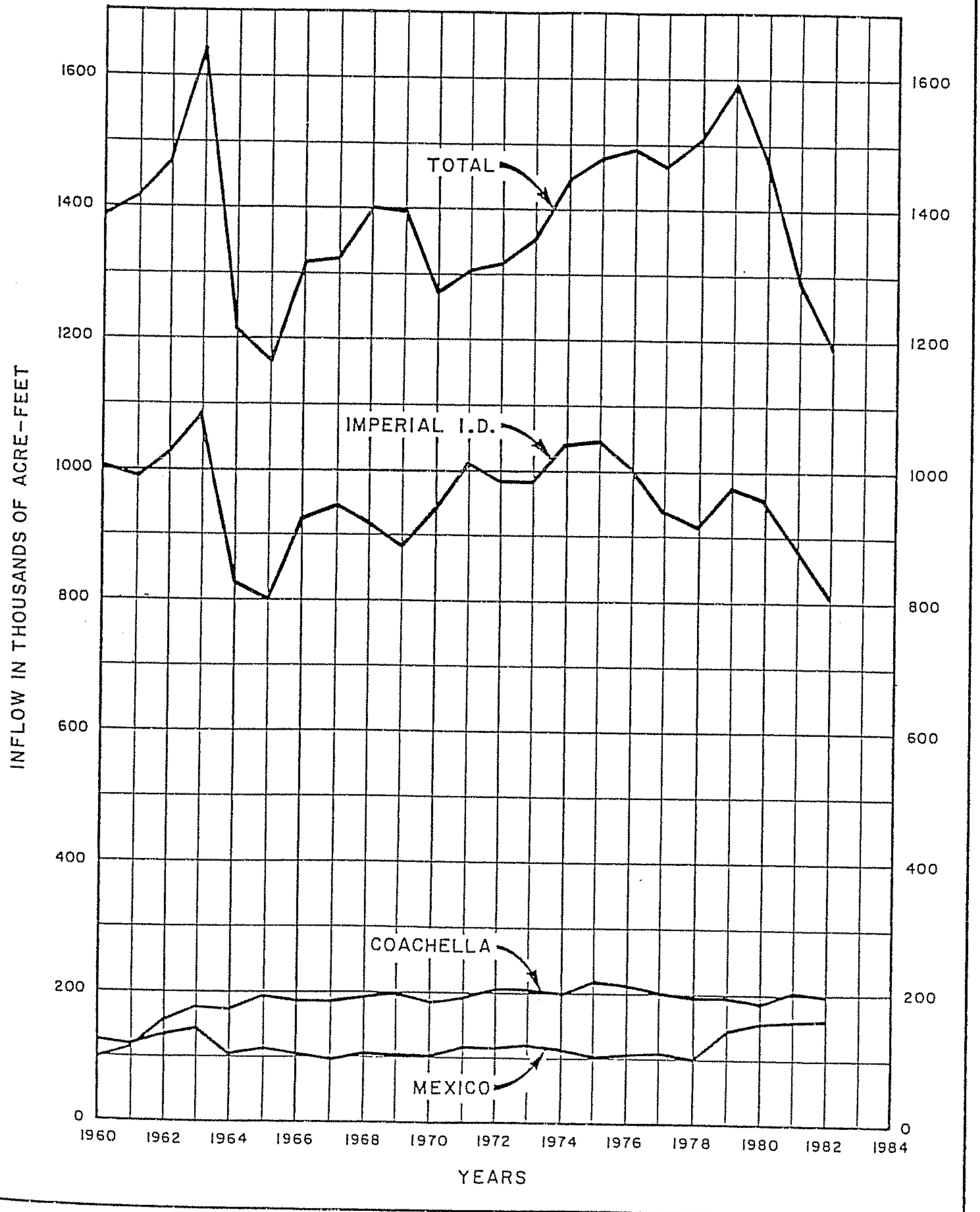
> "During this same period, Imperial Irrigation District inflow contributions decreased from 1,002,000 acre-feet in 1976 to 784,000 acre-feet in 1983, due in large measure to the actions of the Distric and water users to reduce system losses. The water balance for 1983 demonstrates this and the continuing reduction of water losses as well as the increase in efficiency of water use. The reduction in the District's contributions to the Sea during this period has resulted in a lower sea level than otherwise would have existed."

Exhibit II.9 entitled "Components of Inflow to Salton Sea" (attachment 22 to Welsh's affidavit) for the period 1960 - 1983 shows that inflow from the District has generally declined since 1975. This is the period of implementation of the District's current water conservation program.

Exhibit II.10 is a graph entitled "Salton Sea Water Surface Elevation, Historic and Normalized" prepared by Mr. Welsh. It depicts the elevation of the Salton Sea as it actually occurred from 1975 through 1983, compared to elevations under normalized conditions, which assumes long-term average inflow and outflow from sources other than Imperial Valley.

Mr. Welsh concludes in his affidavit:

> "The data documents that the general period of 1976 through 1983, when the Salton Sea rose from an elevation of 230 feet to 226.95 feet below msl, was a period of substantially above long-term normal conditions of rainfall and storm runoff and inflow from Mexico. Inflow from the District, however, substantially declined during this same period."




COMPONENTS OF INFLOW TO SALTON SEA

Exhibit II.9

BOOKMAN-EDMONSTON ENGINEERING, INC.

OCTOBER 1983

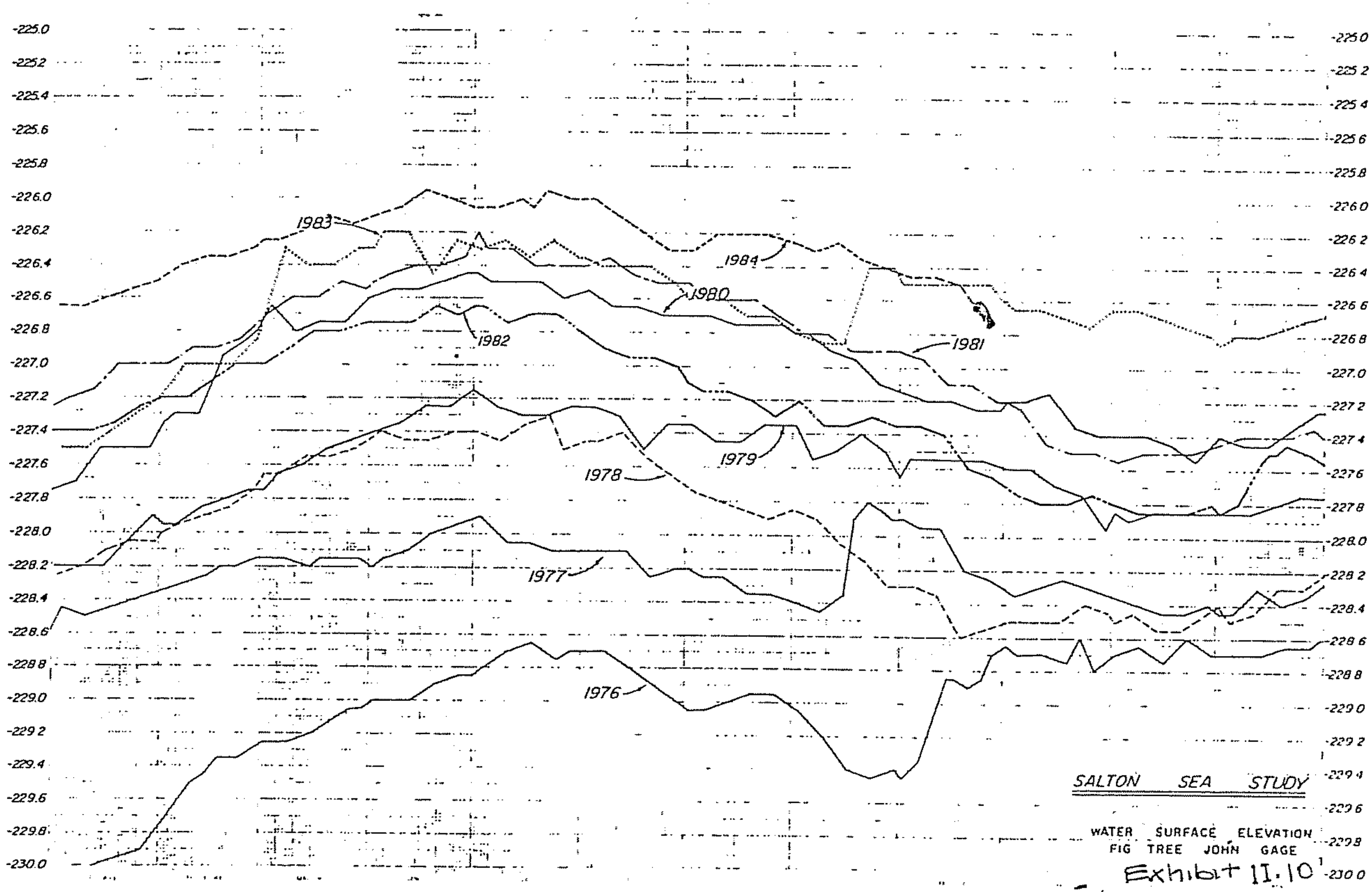



Exhibit II.10

The graph clearly demonstrats the effects of tropical storm Kathleen in 1976, and above-normal (8.10 inches) rainfall added to the increased flow from Mexico.

In a report to the District 2/ dated September, 1982, Mr. John D. Hess stated:

"The conclusions derived thus far indicate that the prime mover for the abnormal rise of the Salton Sea was heavy rainfall between the years 1975 - 1980, inclusive. Imperial Irrigation District contributions to the Sea during this period may be considered normal and inconsequential insofar as the rise in sea level is concerned. Mexico input to the Sea has increased threefold within the past 20 years and, to some extent, this increase is governed by inflow to the Colorado River below regulating structures on the River."

a. Salinity Control of Salton Sea

Recognizing the problem of increasing salinity in the Salton Sea, and that the Sea had become a valuable center of recreational activity, a joint state-federal investigation was begun in 1969 to seek means to preserve the threatened sport fishery and recreational uses of the Sea. It was also recognized, however, that the primary use of the Sea is to serve as a respository for agricultural drainage.

---

2/ "Review of the Department of Water Resources Investigation...Pursuant to Water Code Section 275", prepared by Hess Geotechnical Corporation, ElCentro, California.

Following the reconnaissance study, a feasibility investigation was accomplished and the report entitled "Salton Sea Project, California, Federal-State Feasibility Report" was issued in April 1974.

This report concluded, among other findings, that:

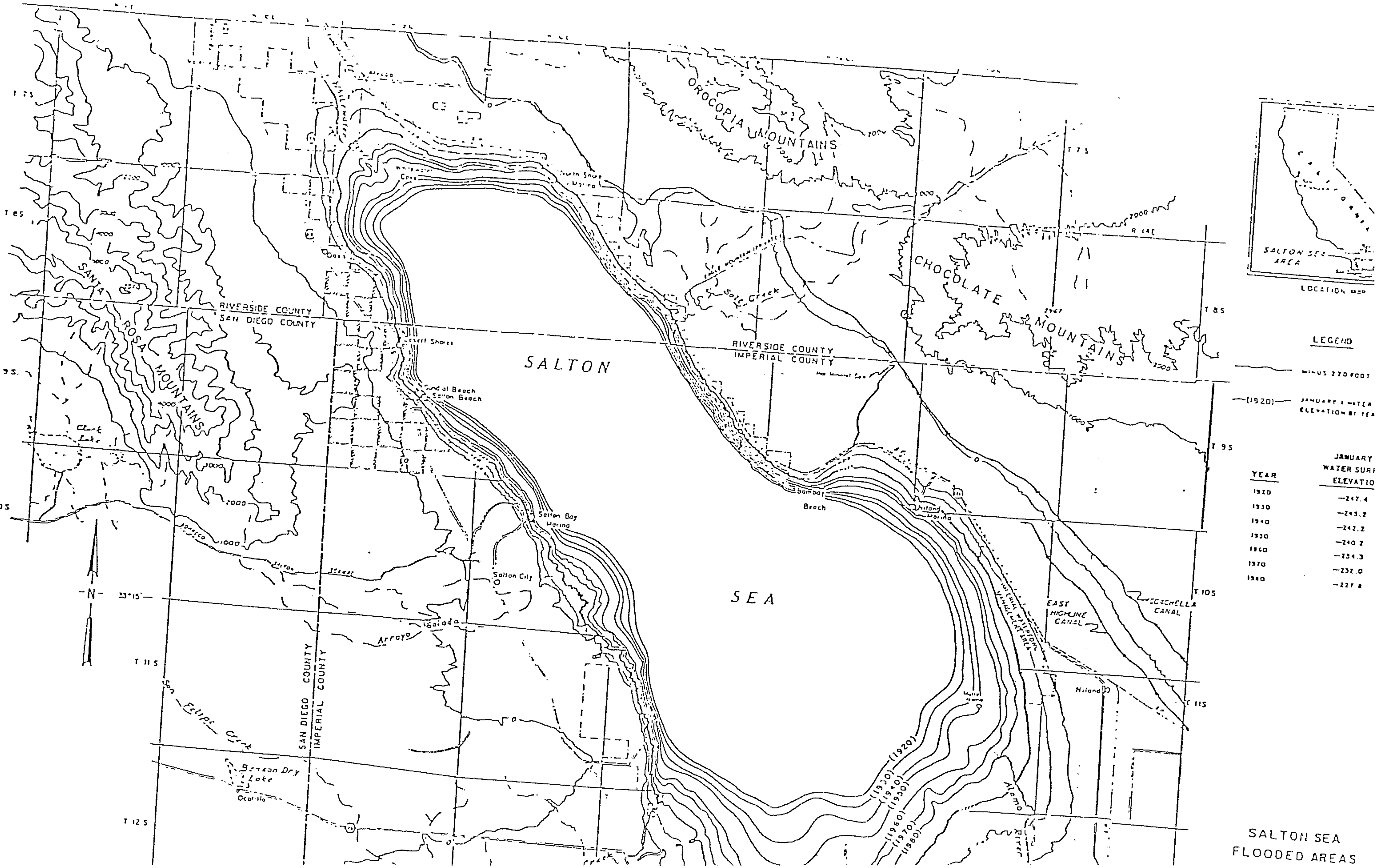
1) Any one of four alternatives presented would be justified by substantial net benefits, and would effectively control the Sea's salinity.

2) The best plan would be the least expensive diked, impoundment.

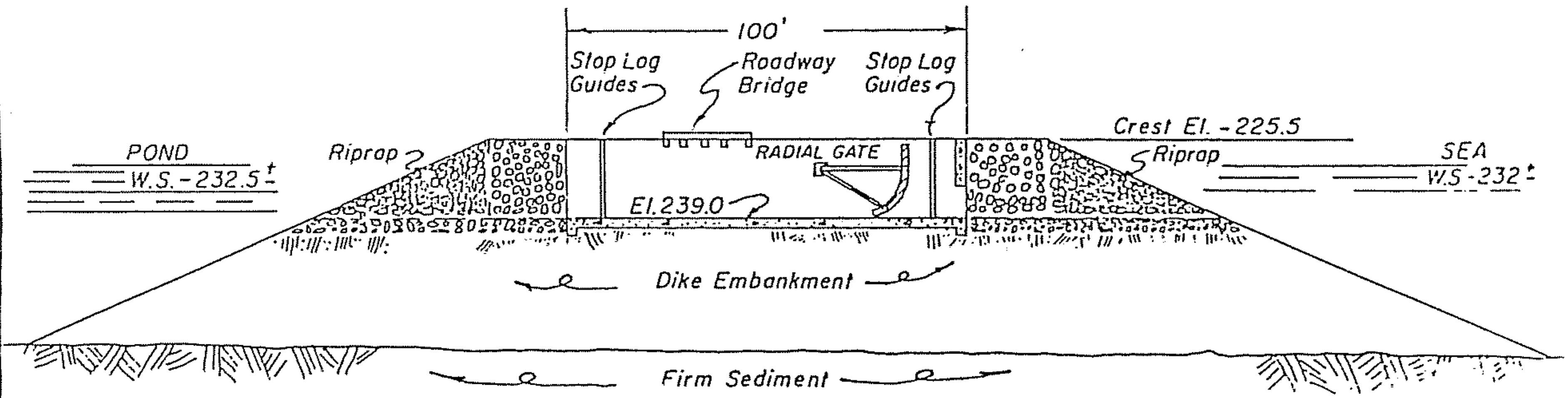
3) Further studies would be required to determine the optimum size of the impoundment and the best methods of construction.

Exhibit II.11 is a map taken from the project report showing location of proposed dikes. Exhibit II.12 is a typical section through the dike.

In the report, federal authorization and construction by the Interior Department were recommended. Such authorization was never granted and the Feasibility Report was put on the shelf. It remains as a project which should be reviewed again for possible implementation in the near future.




SALTON SEA
FLOODED AREAS




NOT TO SCALE

NOTE

Crest elevation to be increased from 40 feet wide to 120 feet wide at inlet structure

Information from

FEDERAL-STATE FEASIBILITY REPORT
SALTON SEA PROJECT-CALIFORNIA

IMPERIAL IRRIGATION DISTRICT

WATER CONSERVATION PLAN

EXHIBIT II.12